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INTRODUCTION

Computer Program Abstracts is an indexed journal containing abstracts of documented computer programs developed by the National Aeronautics and Space Administration, NASA contractors, and other Federal Agencies, which are offered for sale through the NASA sponsored Computer Software Management and Information Center (COSMIC) located at the University of Georgia.

Computer Program Abstracts is published quarterly by the National Aeronautics and Space Administration and is organized into five sections. The first section contains program citations and abstracts arranged in ten major divisions divided into seventy-four specific subject categories and one general category/division. Following are four sections of indexes: subject, originating source, program number/accession number, and equipment requirements.

The Subject Index is an alphabetical listing of the main subject headings by which the computer programs have been identified.

The Originating Source Index is an alphabetical listing of the names of organizations responsible for the computer programs contained in the journal.

The Program Number/Accession Number Index provides a cross-index from the program number assigned in the COSMIC inventory to identify coded source and sequence to the corresponding accession number assigned sequentially to abstracts in *Computer Program Abstracts*.

The Equipment Requirements Index comprises an alphanumeric listing of the kinds of equipment required for the use of the computer programs included in the journal.

Computer programs and related documentation listed in *Computer Program Abstracts* can be ordered at prices indicated in the Abstract Section from COSMIC. Prices are subject to change without notice. Prices include normal shipping charges; special shipping can be arranged at the customer's expense. All orders should specify billing procedures and specific item(s) desired, i.e., documentation only, or both documentation and program.

In most cases, programs described in current issues of this publication are available to domestic customers only. However, many programs announced in previous issues of the journal are available to organizations outside the United States. COSMIC will be pleased to provide information concerning international availability and pricing of software upon request.

Any questions concerning new software announced in *Computer Program Abstracts* or COSMIC's existing inventory of 1500 programs should be directed to the COSMIC Customer Service Staff at the following address:

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The Computer Software Management and Information Center (COSMIC) is operated for NASA by the University of Georgia for the purpose of making computer programs developed in the space program available to the public. Many programs from the Department of Defense and selected software from other government agencies are also offered. At present, over 1500 programs in almost every technical or managerial discipline are available.

Before offering a program for sale, COSMIC ascertains that it will compile and that the documentation describing it is adequate. Then a brief description is written for inclusion in *Computer Program Abstracts*, which is the complete catalog of software that is available. Especially useful programs are also described in *NASA Tech Briefs*, a free quarterly publication containing about 150 articles on NASA innovations of all types thought to have commercial application. To get on the mailing list for Tech Briefs, write NASA, Code ETU-6, Washington, DC 20546.

Another important, and free, service offered by COSMIC is the identification of potentially useful software for customers who are unable to find what they need in the catalog. Simply call or write COSMIC to obtain assistance. Also, in some cases NASA engineers can offer guidance to users in installing or running a program when difficulties are encountered.

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AERONAUTICS

Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics*.

01 AERONAUTICS (GENERAL) N.A.

02 AERODYNAMICS 41

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer*.

03 AIR TRANSPORTATION AND SAFETY N.A.

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation*.

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION N.A.

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Spacecraft Communications, Command and Tracking* and *32 Communications*.

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE N.A.

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.

06 AIRCRAFT INSTRUMENTATION N.A.

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography*.

07 AIRCRAFT PROPULSION AND POWER N.A.

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels*, and *44 Energy Production and Conversion*.

08 AIRCRAFT STABILITY AND CONTROL N.A.

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

09 RESEARCH AND SUPPORT FACILITIES (AIR) N.A.

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

For related information see also *14 Ground Support Systems and Facilities (Space)*.

ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

For related information see also *Aeronautics*.

12 ASTRONAUTICS (GENERAL) N.A.

For extraterrestrial exploration see *91 Lunar and Planetary Exploration*.

13 ASTRODYNAMICS N.A.

Includes powered and free-flight trajectories; and orbit and launching dynamics.

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE) N.A.

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air)*.

15 LAUNCH VEHICLES AND SPACE VEHICLES N.A.

Includes boosters; manned orbital laboratories; reusable vehicles; and space stations.

16 SPACE TRANSPORTATION 42

Includes passenger and cargo space transportation, e.g., shuttle operations; and rescue techniques.

For related information see also *03 Air Transportation and Safety* and *85 Urban Technology and Transportation*.

17 SPACECRAFT COMMUNICATIONS, COMMAND AND TRACKING N.A.

Includes telemetry; space communications networks; astronavigation; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications*.

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE N.A.

Includes spacecraft thermal and environmental control; and attitude control.

For life support systems see *54 Man/System Technology and Life Support*. For related information see also *05 Aircraft Design, Testing and Performance* and *39 Structural Mechanics*.

19 SPACECRAFT INSTRUMENTATION **N.A.**

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography*.

20 SPACECRAFT PROPULSION AND POWER **N.A.**

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion*.

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

23 CHEMISTRY AND MATERIALS (GENERAL) **N.A.**

Includes biochemistry and organic chemistry.

24 COMPOSITE MATERIALS **N.A.**

Includes laminates.

25 INORGANIC AND PHYSICAL CHEMISTRY **42**

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics*.

26 METALLIC MATERIALS **N.A.**

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

27 NONMETALLIC MATERIALS **N.A.**

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

28 PROPELLANTS AND FUELS **N.A.**

Includes rocket propellants, igniters, and oxidizers; storage and handling; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion*.

ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

For related information see also *Physics*.

31 ENGINEERING (GENERAL) **N.A.**

Includes vacuum technology; control engineering; display engineering; and cryogenics.

32 COMMUNICATIONS **N.A.**

Includes land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Spacecraft Communications, Command and Tracking*.

33 ELECTRONICS AND ELECTRICAL ENGINEERING **42**

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics*.

34 FLUID MECHANICS AND HEAT TRANSFER **43**

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics*.

35 INSTRUMENTATION AND PHOTOGRAPHY **N.A.**

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources*. For related information see also *06 Aircraft Instrumentation* and *19 Spacecraft Instrumentation*.

36 LASERS AND MASERS **N.A.**

Includes parametric amplifiers.

37 MECHANICAL ENGINEERING **43**

Includes auxiliary systems (non-power); machine elements and processes; and mechanical equipment.

38 QUALITY ASSURANCE AND RELIABILITY **43**

Includes product sampling procedures and techniques; and quality control.

39 STRUCTURAL MECHANICS **44**

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance*.

GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

For related information see also *Space Sciences*.

42 GEOSCIENCES (GENERAL) **N.A.**

43 EARTH RESOURCES **N.A.**

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography*.

44 ENERGY PRODUCTION AND CONVERSION **44**

Includes specific energy conversion systems, e.g., fuel cells and batteries; global sources of energy; fossil fuels; geophysical conversion; hydroelectric power; and wind power.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *85 Urban Technology and Transportation*.

45 ENVIRONMENT POLLUTION **N.A.**

Includes air, noise, thermal and water pollution; environment monitoring; and contamination control.

46 GEOPHYSICS **N.A.**

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation*.

47 METEOROLOGY AND CLIMATOLOGY **N.A.**

Includes weather forecasting and modification.

48 OCEANOGRAPHY **N.A.**

Includes biological, dynamic and physical oceanography; and marine resources.

LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

51 LIFE SCIENCES (GENERAL) **N.A.**

Includes genetics.

52 AEROSPACE MEDICINE **N.A.**

Includes physiological factors; biological effects of radiation; and weightlessness.

53 BEHAVIORAL SCIENCES **N.A.**

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT **N.A.**

Includes human engineering; biotechnology; and space suits and protective clothing.

55 PLANETARY BIOLOGY **N.A.**

Includes exobiology; and extraterrestrial life.

MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL) **N.A.**

60 COMPUTER OPERATIONS AND HARDWARE **N.A.**

Includes computer graphics and data processing.

For components see *33 Electronics and Electrical Engineering*.

61 COMPUTER PROGRAMMING AND SOFTWARE **N.A.**

Includes computer programs, routines, and algorithms.

62 COMPUTER SYSTEMS **N.A.**

Includes computer networks.

63 CYBERNETICS **N.A.**

Includes feedback and control theory.

For related information see also *54 Man/System Technology and Life Support*.

64 NUMERICAL ANALYSIS **45**

Includes iteration, difference equations, and numerical approximation.

65 STATISTICS AND PROBABILITY **45**

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

66 SYSTEMS ANALYSIS **N.A.**

Includes mathematical modeling; network analysis; and operations research.

67 THEORETICAL MATHEMATICS **N.A.**

Includes topology and number theory.

PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

For related information see also *Engineering*.

70 PHYSICS (GENERAL) **N.A.**

For geophysics see *46 Geophysics*. For astrophysics see *90 Astrophysics*. For solar physics see *92 Solar Physics*.

71 ACOUSTICS 45
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73 NUCLEAR AND HIGH-ENERGY PHYSICS N.A.
Includes elementary and nuclear particles; and reactor theory.
For space radiation see *93 Space Radiation*.

74 OPTICS N.A.
Includes light phenomena.

75 PLASMA PHYSICS N.A.
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76 SOLID-STATE PHYSICS N.A.
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For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers*.

77 THERMODYNAMICS AND STATISTICAL PHYSICS N.A.
Includes quantum mechanics; and Bose and Fermi statistics.
For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer*.

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

80 SOCIAL SCIENCES (GENERAL) N.A.
Includes educational matters.

81 ADMINISTRATION AND MANAGEMENT 46
Includes management planning and research.

82 DOCUMENTATION AND INFORMATION SCIENCE N.A.
Includes information storage and retrieval technology; micrography; and library science.
For computer documentation see *61 Computer Programming and Software*.

83 ECONOMICS AND COST ANALYSIS N.A.
Includes cost effectiveness studies.

84 LAW AND POLITICAL SCIENCE N.A.
Includes space law; international law; international cooperation; and patent policy.

85 URBAN TECHNOLOGY AND TRANSPORTATION N.A.
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.
For related information see *03 Air Transportation and Safety*, *16 Space Transportation*, and *44 Energy Production and Conversion*.

SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.
For related information see also *Geosciences*.

88 SPACE SCIENCES (GENERAL) N.A.

89 ASTRONOMY N.A.
Includes radio and gamma-ray astronomy; celestial mechanics; and astrometry.

90 ASTROPHYSICS N.A.
Includes cosmology; and interstellar and interplanetary gases and dust.

91 LUNAR AND PLANETARY EXPLORATION N.A.
Includes planetology; and manned and unmanned flights.
For spacecraft design see *18 Spacecraft Design, Testing and Performance*. For space stations see *15 Launch Vehicles and Space Vehicles*.

92 SOLAR PHYSICS N.A.
Includes solar activity, solar flares, solar radiation and sunspots.

93 SPACE RADIATION N.A.
Includes cosmic radiation; and inner and outer earth's radiation belts.
For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

GENERAL

99 GENERAL N.A.

Note: N.A. means that no abstracts were assigned to this category for this issue.

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TYPICAL CITATION AND ABSTRACT

NASA SPONSORED PROGRAM
ORIGINATING SOURCE
NASA ACCESSION NUMBER
M79-10003* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
GEMPAK: AN ARBITRARY AIRCRAFT GEOMETRY GENERATOR
TITLE
PROGRAM LANGUAGE
FORTRAN IV 5865 source statements
CDC 6000
MACHINE REQUIREMENTS
PROGRAM NUMBER
LAR-12515 Price: Program $790.00/Documentation $19.50
PRICE
The computer program, GEMPAK, was developed to aid designers in the generation of detailed configuration geometry. This program was written to allow the user as much flexibility as possible in his choice of configurations and detail of description desired while at the same time, keeping input requirements, program turnaround time, and cost to a minimum. Routines that generate fuselage and planar surface (wing-like) geometry and a routine that determines the true intersection of all components with the fuselage are provide. The GEMPAK is comprised of three major parts: the fuselage generator, the generator for planar surfaces, and the module for integrating the configuration components with the fuselage. Each component is input and generated independently. The resulting individual geometries are scaled for compatibility and then merged into an integrated configuration. Three modes of modeling the fuselage are included: (1) complete lofting where the fuselage is defined analytically by three to eleven lofting curves that may be continuous or discontinuous. The user needs to input a good reproduction of his configuration; cross-section lofting this mode is structured around lofting data input for discrete prescribed cross-section locations; (3) a point by point mode and that requires all surface points be input at discrete longitudinal locations. No interpolation routines are provided in either longitudinal or cross-sectional directions. The amount of required input is least for mode one and greatest for mode three. The wing, canard, horizontal tail, fin, and elevon are all generated with a single type of calculation. There are two basic options for input to this part of the airfoil section. The first is to generate a one- or two-panel surface with basic input parameters such as aspect ratio, taper ratio, and sweep angle. The second is to input a point by point description of the airfoil. Once the airfoil description is entered by either method there are program options to change dihedral, twist, coordinate translation, angle of attack, and roll angle of the previously defined airfoil. After all of the geometry for the separate parts is generated, then control passes to the merge section of the program. Merge calculates the intersection of all the planar surfaces with the fuselage. This program is implemented in FORTRAN 4 on a CDC 6000 series machine with a central memory requirement of approximately 55k (octal) of 60 bit words.

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02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

M79-10114 Lockheed Aircraft Corp., Burbank, Calif.
VORLAX: A GENERALIZED VORTEX LATTICE METHOD FOR SUBSONIC AND SUPERSONIC FLOW APPLICATIONS
FORTRAN IV (99 percent), COMPASS (1 percent) 9,935 source statements
CDC CYBER 70
LAR-12636 Price: Program $970.00/Documentation $17.50

The several variations of the vortex lattice method that are currently available have proven to be very practical and versatile theoretical tools for the aerodynamic analysis and design of planar and nonplanar configurations. The success of the method is due in great part to the relative simplicity of the numerical technique involved and to the accuracy of the results obtained, however, most of the available procedures are for subsonic flow applications. The VORLAX program was developed to incorporate a direct extension of the vortex lattice method into the supersonic flow regime thus providing the analyst with a full flow range capability. VORLAX has the capability of calculating the aerodynamic load distributions at subsonic and supersonic speeds for arbitrary nonplanar configurations. It is also capable of the inverse process, namely, the computation of the surface warp required to achieve a given load distribution. Correlations with experimental data have shown good agreement in the overall force and moment coefficients due to lift and in the distribution of load coefficients. If the discrete vortex lattice is considered as an approximation to the surface-distributed vorticity, the generalized principal part of the solution integral yields a residual term to the vorticity-induced velocity field. This term is incorporated into the velocity field generated by the discrete vortex lines, thus making the vortex lattice method valid for supersonic flows. Techniques for simulating nonzero thickness lifting surfaces and fusiform bodies with vortex lattice elements are included in the VORLAX program. Thickness effects of wing-like components are simulated by a double (biplanar) vortex lattice layer. Fusiform bodies are represented by a vortex grid arranged on a series of concentric cylindrical surfaces to simulate volume displacement effects and to accurately compute surface pressure distributions. A special technique was developed for the VORLAX program to perform the analysis of sideslip effects. The technique uses a combination of the skewed-wing approach and the skewed free-stream approach. The formulation utilizes a first order perturbation solution which does not involve the geometrical complications of the skewed-wing approach. Input to VORLAX consists of data including configuration geometry, free stream parameters, and solution control parameters. Output includes vortex element locations, pressure coefficients, circulation strengths, and computational parameters. This program is written in FORTRAN 4 and COMPASS for batch execution and has been implemented on a CDC CYBER 175 with a central memory requirement of approximately 217K (octal) of 60 bit words. The VORLAX program was developed in 1977.

M79-10115* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPUTER PROGRAM FOR CALCULATING THE FLOW FIELD IN SUPERSONIC MIXED-COMPRESSION INLETS USING THREE-DIMENSIONAL METHOD OF CHARACTERISTICS
FORTRAN IV 6,860 source statements
CDC 6000
LEW-13279 Price: Program $650.00/Documentation $37.00

This computer program calculates the flow field in the supersonic portion of a mixed-compression aircraft inlet at nonzero angle of attack. This approach is based on the method of characteristics for steady three dimensional flow. The results of this program agree with those produced by the two dimensional method of characteristics when axisymmetric flow fields are calculated. Except in regions of high viscous interaction and boundary layer removal, the results agree well with experimental data obtained for three dimensional flow fields. The flow field in a variety of axisymmetric mixed compression inlets can be calculated using this program. The bow shock wave and the internal shock wave system are calculated using a discrete shock wave fitting procedure. The internal flow field can be calculated either with or without the discrete fitting of the internal shock wave system. The influence of molecular transport can be included in the calculation of the external flow about the forebody and in the calculation of the internal flow when internal shock waves are not discretely fitted. The viscous and thermal diffusion effects are included by treating them as correction terms in the method of characteristics procedure. Dynamic viscosity is represented by Sutherland's law and thermal conductivity is represented as a quadratic function of temperature. The thermodynamic model used is that of a thermally and calorically perfect gas. The program assumes that the cowl lip is contained in a constant plane and that the centerbody contour and cowl contour are smooth and have continuous first partial derivatives. This program cannot calculate subsonic flow, the external flow field if the bow shock wave does not exist entirely around the forebody, or the internal flow field if the bow flow field is injected into the annulus. Input to the program consists of parameters to control execution, to define the geometry, and the vehicle orientation. Output consists of a list of parameters used, solution planes, and a description of the shock waves. This program is written in FORTRAN 4 for batch execution and has been implemented on a CDC 6000 series machine with a central memory requirement of 110K (octal) of 60 bit words when it is overlayed. This flow analysis program was developed in 1978.

16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation e.g., shuttle operations; and rescue techniques.

For related information see also *03 Air Transportation and Safety* and *85 Urban Technology and Transportation*.

M79-10116 Rockwell International Corp., Canoga Park, Calif.
RIGID SURFACE INSULATION INSTALLATION AND THERMAL STRESSES
FORTRAN IV 1,194 source statements
CDC CYBER 70
MSC-18560 Price: Program $310.00/Documentation $19.00

The thermal protection systems for the space shuttle orbiter consist of rigid surface insulation (RSI) tiles bonded to the orbiter structure. These tiles will be subjected to stress during installation and use. A computer program has been developed to determine the effects of these stresses on the RSI tiles. During installation the tiles will be subjected to sinusoidal out-of-plane substrate deflections due to pressure bulging and tile/structure mismatches. During the shuttle mission the tiles will be subjected to in-plane substrate loading and significant temperature gradients. This program uses a closed form analysis to predict the stresses that the RSI tiles will experience. The stress data determined by this program is useful in analyzing the structural integrity of the thermal protection system. This stress determination procedure could be applied to any form of modular insulation which is installed by bonding, such as ceramic tile insulation for furnaces and polyurethane foam insulation for LNG containers. This program is written in FORTRAN 4 for batch execution and has been implemented on a CDC CYBER 70 series machine with a central memory requirement of approximately 55K (octal) of 60 bit words. This program was developed in 1979.

25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics*.

M79-10117* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN IMPROVED VISCOUS CHARACTERISTICS ANALYSIS PROGRAM
FORTRAN IV 5,170 source statements
CDC CYBER 70
LAR-12598 Price: Program $810.00/Documentation $24.50

Current investigations of the hydrogen-fueled supersonic combustion ramjet engine have delineated several technological problem areas. One area, the analysis of the injection, turbulent mixing, and combustion of hydrogen, requires the accurate calculation of the supersonic combustion flow fields. This calculation has proven difficult because of an interesting phenomena which makes possible the transition from supersonic to subsonic flow in the combustion field due to the temperature transitions which occur in the flow field. This computer program was developed to use viscous characteristics theory to analyze supersonic combustion flow fields with imbedded subsonic regions. Intended to be used as a practical design tool for two dimensional and axisymmetric supersonic combustor development, this program has proven useful in the analysis of such problems as determining the flow field of a single underexpanded hydrogen jet, the internal flow of a gas sampling probe, the effects of fuel injector strut shape, and the effects of changes in combustor configuration. Both combustion and diffusive effects can significantly alter the wave pattern in a supersonic field and generate significant pressure gradients in both the axial and radial directions. The induced pressure, in turn, substantially influences the ignition delay and reaction times as well as the velocity distribution. To accurately analyze the flow fields, the effects of finite rate chemistry, mixing, and wave propagation must be properly linked to one another. The viscous characteristics theory has been used in the past to describe flows that are pure supersonic; however, the interacting pressure effects in the combustor often allows for the development of shock waves and imbedded subsonic regions. Numerical investigation of these transonic situations has required the development of a new viscous characteristics procedure which is valid within the subsonic region and can be coupled with the standard viscous characteristics procedure in the supersonic region. The basic governing equations used are the 'viscous-inviscid' equations, similar to those employed in higher order boundary layer analyses, with finite rate chemistry terms included. In addition, the Rankine-Hugoniot and Prandtl-Meyer relations are used to compute shock and expansion conditions. The program can handle up to 20 simultaneous shock waves. Chemistry terms are computed for a 7-species 8-mechanism hydrogen-air reaction scheme. The user input consists of a physical description of the combustor and flow determination parameters. Output includes detailed flow parameter values at selected points within the flow field. This computer program is written in FORTRAN 4 for batch execution and has been implemented on a CDC CYBER 175 with a central memory requirement of approximately 114K (octal) of 60 bit words. The program was developed in 1978.

33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics*.

M79-10118 Systems Science and Software, La Jolla, Calif.
NASCAP: NASA CHARGING ANALYZER PROGRAM
FORTRAN V 35,215 source statements
UNIVAC 1100
LEW-12973 Price: Program $1750.00/Documentation $72.00

Bombarded by ions and electrons, a satellite will accumulate, emit, and redistribute electrical charges, as well as undergo material degradation. The proper functioning of spacecraft components may be seriously impaired if the induced potentials become excessive. Predicting a spacecraft's response to a charged particle environment is complicated by the fact that the flux of particles is substantially influenced by the satellite's own changing electromagnetic field. The NASA Charging Analyzer Program, NASCAP, was developed to accurately model the dynamics of spacecraft response to realistic plasma environments. NASCAP can effectively simulate the charging of geometrically, materially, and electrically complex objects in both ground test and magnetosphere environments. The NASCAP program should prove valuable in the analysis of any structure or component subjected to an electrically active environment. The approach utilized by the NASCAP program is a timestep procedure calculating one quasi-static state after another. Initially, all potentials and charge distributions are specified by the user as a starting condition. The dynamics of the problem are driven by the charge accumulation of the body from external sources, charge depletion, and conduction in dielectrics. Each timestep includes a full three dimensional electrostatic potential calculation. To determine the potential field, NASCAP employs a finite element approach utilizing right parallelepiped elements and blended linear univariance edge interpolates to solve Poisson's equation over a grid of varying mesh element sizes. This calculation is time staggered with a procedure in which incident charged particle fluxes, leakage currents, emission currents, and induced space charge effects are computed based on the previously derived quasi-static conditions. Flux calculations solve the Vlasov equation using the time symmetric, reverse trajectory method. The associated charging currents are determined for the computed conditions.

These procedures limit NASCAP to situations where the Debye length of the ambient plasma environment is long compared to the dimensions of the object being studied. The user specifies the object geometry, material properties, any significant electrical properties of the object, and the ambient plasma environment. Output from NASCAP includes a time history of object charging, potential contours, charge contours, current contours, and particle trajectories. The NASCAP program is written in FORTRAN 5 for batch execution and has been implemented on the UNIVAC 1100 series computer with a central memory requirement of approximately 62K of 36 bit words. The NASCAP program was developed in 1978.

34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics*.

M79-10119 General Electric Co., Philadelphia, Pa.
THE STEAMTUBE CURVATURE ANALYSIS PROGRAM
FORTRAN IV (99 percent), CDC ASSEMBLER (1 percent) 15,532 source statements Updated; previously announced as M74-10104
CDC 6000
LAR-11535 Price: Program $1120.00/Documentation $65.00

Aircraft are now being designed which incorporate supercritical wing technology to operate efficiently at transonic cruise speeds. Nacelle installations with low drag and high drag-divergence Mach number are essential to the success of these designs. The Streamtube Curvature Analysis Program was developed to accurately calculate the inviscid pressure distribution and flow field, including viscous displacement effects, around an arbitrary axisymmetric ducted body at transonic speeds. This computerized flow field analysis is designed to predict the transonic flow around long and short high-bypass-ratio fan duct nacelles with inlet and outlet flows having appropriate aerothermodynamic properties. This analysis technique provides the means to conduct parametric studies so that nacelle design criteria can be evaluated and configurations selected for further experimental investigations. The inviscid solution technique used is based on a stream tube curvature method. Engineers frequently rely on one dimensional compressible flow relationships for a first-order solution to ducted flow. The stream tube curvature approach is similar except that a number of confluent streamtubes, with slightly different properties, are added together to obtain the total flow in the channel. This method exactly satisfies the inviscid equations of motion in the limit as the size of the individual streamtubes approaches zero. This program utilizes an automatic grid refinement procedure and solves the flow field equations with a matrix relaxation technique. The location of incipient turbulent boundary layer separation is identified when the calculated pressure gradients indicate sufficient cause. Due to its significance to performance predictions, a boundary layer displacement calculation is coupled with the inviscid analysis. A compressible turbulent boundary layer solution is computed using the method of Stratford and Beavers, with turbulent separation predicted by the method of Stratford. Inclusion of these effects allows for accurate evaluation of all nacelle forces. The user only needs to supply the program with configuration data, boundary coordinates, and channel flow properties. Program output includes solution history, flow data, and boundary layer data. The predicted pressure distributions have been favorably compared with through-flow nacelle test results obtained in wind tunnel tests. This program is written in FORTRAN 4 and COMPASS for batch execution and has been implemented on the CDC CYBER 175 with a central memory requirement of approximately 108K (octal) of 60 bit words. The Streamtube Curvature Analysis program was developed in 1972 and most recently updated in 1975.

37 MECHANICAL ENGINEERING

Includes auxiliary systems (non-power); machine elements and processes; and mechanical equipment.

M79-10120 Virginia Univ., Charlottesville.
ROTOR TRANSIENT ANALYSIS BY THE MODAL METHOD
FORTRAN IV 1,900 source statements
IBM 360
LEW-13230 Price: Program $560.00/Documentation $26.00

The design and manufacturing of large and complex turbomachinery has been hampered by both technical and theoretical problems of bearing lubrication and shaft dynamics. The problems concerning the dynamics of rotor-bearing systems become more pronounced in designs requiring a rotor capable of operating under adverse conditions of temperature, speed, and load. This computer program was developed to provide the analyst with a simple and fast method for accurately simulating rotor-bearing systems. The simulation provides the designer with complete design information including critical speeds and modes, amplification factors, stability data, steady state and transient forced responses, and frequency spectrum data. The simulation is performed in terms of a problem in flexible rotor dynamics with the assumption that the shaft is linearly elastic with applied loads. This simulation has proved valid for most rotor systems. In general, a typical rotor system may consist of multiple bearings, and the rotor shaft may have disk or impellers located inboard or outboard of the main bearing. Special characteristics may include imbalances in the disks and impellers, skewness of the disk to the rotor shaft, and mechanical bowing of the shaft. These characteristics may be considered as part of the external forces acting on the rotor. General equations of motion for the multimass bearing system are derived by dividing the rotor into discrete mass stations. The dynamics of the rotor system are represented by the forces and displacements at these mass stations. Bending moments are taken to vary linearly between these mass stations using the small deflection assumption. The problem is solved using a finite element method where a shaft stiffness matrix is constructed from the mass station model. Standard finite element calculations are used to calculate total displacement, residual displacements, and eigenvalue problem solutions. This data is then used to determine the rotor system design parameters. The use of a finite element type modal calculation provides a fast and accurate manner of performing transient analyses. Input to the program consists of a simple description of the rotor-bearing system and optional analysis control variables. Output from the program includes simulation processing data as well as resultant design information. This program is written in FORTRAN 4 for batch execution and has been implemented on an IBM 360 with a central memory requirement of approximately 190K of 8 bit bytes. This rotor analysis program was developed in 1977.

38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

M79-10121 Naval Ship Engineering Center, Washington, D. C.
TIGER: A COMPUTER SYSTEM TO ESTIMATE VARIOUS RELIABILITY, READINESS, AND AVAILABILITY MEASURES
FORTRAN IV 1,890 source statements
CDC 6000
DOD-00070 Price: Program $540.00/Documentation $15.50

This computer simulation program, TIGER, was developed to aid in the evaluation of a complex system in terms of reliability, readiness, and availability. The system under study can range in complexity from a single piece of equipment, such as a radar or sonar unit, to a complete functional system, such as a ship or an airplane. For a system consisting of only a few pieces of

equipment, system reliability, readiness, and availability can be calculated analytically from the equipment mean-time-between-failure (MTBF) and mean-time-to-repair (MTTR). As a system becomes more complex, such calculations become increasingly difficult and time consuming. For complex systems, these measurements can be more readily derived by simulation system performance over a specified period of time. TIGER uses Monte Carlo simulation techniques to provide the analyst with a generalized capability for determining system reliability, readiness, and availability estimates. The complex system to be simulated is divided into subsystems. These subsystems are further divided down to any level necessary to accurately depict the system. The lowest level of definition is that which can be described by MTBF, MTTR, and duty-cycle (DC). The system configuration is defined in terms of the top-down logical relationships between the subsystems, groups, and individual pieces of equipment. The successive phases to be simulated are determined by defining, in order, each phase, phase type, and phase duration. A maximum of 95 phases and six phase types may be defined. The actual simulation of the system is performed on a 'next-event' basis. For a given mission length, the Monte-Carlo simulation produces various reliability, readiness, and availability measures for use by the system analyst. This program is written in FORTRAN 4 for batch execution and has been implemented on a CDC 6600 with a central memory requirement of approximately 145K (octal) of 60 bit words. The TIGER program was developed in 1979.

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance*.

M79-10122 Rockwell International Corp., Canoga Park, Calif.
COMPUTER CALCULATION OF FRACTURE MECHANICS PROOF TEST LOGIC
FORTRAN IV 451 source statements
IBM 370
MFS-19420 Price: Program $230.00/Documentation $5.00

The prediction of structural crack propagation is an important requirement in many engineering applications. This computer program was developed to perform the calculation of fracture mechanics proof test logic. The first step in performing the proof test logic calculation is to determine the largest flaw that may exist in the structural part at the beginning of service loading. A part-through crack is defined by its surface length, crack shape, and sub-surface length. This program assumes an initial semielliptical crack shape with a set aspect ratio. Thus a complete description of the flaw is determined by the initial crack depth. The calculation of the initial depth and subsequent crack growth is based on stress intensity functions. The program calculates stress intensities due to lending and axial loads using a linear superposition to combine loading conditions. The program analysis continues throughout the service life of the part until catastrophic failure occurs. This program is written in FORTRAN 4 for batch execution and has been implemented on an IBM 360 with a central memory requirement of approximately 36K of 8 bit bytes. This Proof Test Logic program was developed in 1976.

M79-10123 Grumman Aerospace Corp., Bethpage, N.Y.
STARS: SHELL THEORY AUTOMATED FOR ROTATIONAL STRUCTURES
FORTRAN IV 27,000 source statements Updated; previously announced as M75-10093
UNIVAC 1100
MFS-23027 Price: Program $2410.00/Documentation $118.00

Many engineering structures, such as aircraft bodies, spacecraft, submarines, and storage tanks, can be efficiently analyzed using shell theory. Several methods are currently available to solve the equations derived from shell theory. STARS, Shell Theory Automated for Rotational Structures, was developed to incorporate the method of numerical integration into a package of programs which use Love-Reissner first order shell theory to numerically analyze shells of revolution. The programs in the STARS package can perform static, buckling, vibration, and plastic analyses on thin shells of revolution subjected to distributed loads, concentrated line loads, and thermal strain. A wide range of shell wall cross sections and combinations of geometric shapes can be effectively handled by these programs. The STARS package provides the structural analyst with a very general shell handling capability. For the STARS analysis, the structure under study is divided into numerous shell regions. Each of these regions must be a singly-connected shell. The regions are further subdivided into several shell segments, each being free to have its own geometric shape. Stiffness matrices obtained for each segment are coupled to determine regional stiffnesses. These regional stiffness matrices are reduced and coupled to form the stiffness matrix of the total structure. In the linear analysis of unsymmetrically loaded shells, the partial differential equations of shell theory are reduced to first order differential equations and solved using a Runge-Kutta method of numerical integration. STARS may also be used for nonlinear analysis of axisymmetric loaded shells. The analysis of these plastic, large deformation cases is accomplished by a special solution iteration scheme. The user supplies STARS with segment geometric data, segment orientation and coupling data, joint freedom data, and structural material data. Output from STARS includes stresses, displacements, plastic strains, and vibration and buckling results. The STARS package is written in FORTRAN 4 for batch execution and has been implemented on a UNIVAC 1108 with a central memory requirement of 53K of 36 bit words when segmented. The STARS package was developed in 1975.

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells and batteries; global sources of energy; fossil fuels; geophysical conversion; hydroelectric power; and wind power.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *85 Urban Technology and Transportation*.

M79-10124 Oak Ridge National Lab., Tenn.
PRESTO: A COMPUTER CODE FOR THE PERFORMANCE OF REGENERATIVE SUPERHEATED STEAM TURBINE CYCLES
FORTRAN IV 8,165 source statements Prepared in cooperation with Union Carbide Corp., N.Y.
IBM 360
LEW-13392 Price: Program $1150.00/Documentation $18.00

One of the most important factors in the design of base-load or peak-load power plants is an accurate analysis of the steam turbine cycles involved. Several new engineering options are available in the design of steam turbine cycles which can significantly increase the generating efficiency of these power plants. Of particular interest are the reheat and regenerative steam turbine cycles which utilize the superheated steam normally available from large fossil fueled steam turbines. The PRESTO computer program was developed to analyze the performance of a wide range of steam turbine cycles with special attention given to regenerative superheated steam turbine cycles. PRESTO can be used to model standard turbine cycles, including such features as process steam extraction, induction and feedwater heating by external sources, peaking, and high back pressure. Expansion line efficiencies, exhaust loss, leakages, mechanical losses, and generator losses are used to calculate the cycle heat rate and the generator output. PRESTO provides the power engineer with a flexible aid for the design and analysis of steam

turbine systems. PRESTO calculates the expansion line efficiency as a function of volume flow, pressure ratio, initial pressure, initial temperature, and the governing stage design. This expansion line calculation is used along packing leakages, valve steam leakages, mechanical losses, exhaust losses, and generator losses to determine the heat rate and generator output. The PRESTO user specifies the throttle steam thermodynamic properties, the preliminary conditions of the governing stage, system pressure relations, and condenser conditions, as well as the cycle configuration. PRESTO calculates the working parameters for the cycle and executes a performance analysis of the full steam turbine cycle. The PRESTO analysis is performed by an iterative procedure which calculates the system operating parameters. All iterations begin at the high-pressure end of the cycle and progress toward the condenser. The use of this iterative procedure allows PRESTO to easily handle such options as parallel or series external heat input, process stream extraction, regressive feedwater heating, and reheaters. PRESTO output includes cycle heat rate, cycle efficiency, generator output, losses, and other useful system parameters. This program is written in FORTRAN 4 for batch execution and has been implemented on an IBM 360 with a central memory requirement of approximately 230K of 8 bit bytes. PRESTO was developed in 1979.

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

M79-10125* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SINDA: SYSTEMS IMPROVED NUMERICAL DIFFERENCING ANALYZER
FORTRAN IV (99 percent), COMPASS (1 percent) 37,000 source statements
CDC CYBER 70
MSC-18597 Price: Lease $2375.00/Documentation $73.00

SINDA, the Systems Improved Numerical Differencing Analyzer, is a software system developed for solving physical problems governed by diffusion-type equations which can be modeled by lumped parameter representation. The system is most widely used as a general thermal analyzer with resistor-capacitor network representations, but may be adapted to a wide range of problems represented by differential equations, such as Fourier, Poissons, or LaPlace equations. SINDA can numerically solve most any set of ordinary differential equations, which may be used to represent the transient behavior of a lumped parameter system, or any set of nonlinear algebraic equations, which might represent the steady state conditions of a physical system. For user decision flexibility, SINDA offers a number of numerical solution techniques. These include such finite difference formulations of the explicit method as: forward-difference explicit approximation, DuFort-Frankel approximation, exponential approximation, and alternating direction approximation; also such formulations of the implicit method as: backward-difference implicit approximation and Crank-Nicolson approximation. The practical analysis of many physical problems, particularly thermal analysis problems, can be readily achieved with the SINDA system. The SINDA system consists mainly of a preprocessor and a subroutine library. The SINDA preprocessor accepts programs written in the SINDA language and converts them into standard FORTRAN programs. The SINDA language is designed for working with lumped parameter representations and finite difference solution techniques. The SINDA library consists of a large number of prewritten FORTRAN subroutines that perform a variety of commonly needed actions. The user may call these subroutines from their SINDA language program, thus greatly reducing the programming efforts required to solve many problems. Most of the subroutines in the SINDA library were developed for use in solving thermal analysis problems. As a thermal analyzer, SINDA can handle such interrelated complex phenomena as sublimation, diffuse radiation within enclosures, transport delay effects, sensitivity analysis, and thermal network error correction. Special subroutines are included in the SINDA library to facilitate the thermal analysis of systems incorporating fluid flow networks. SINDA can easily account for pumps, valves, and heat exchangers during a thermal analysis. The user written SINDA language program determines the input data required and the information which is produced as output by the program. This program is written in FORTRAN 4 and ASSEMBLER and has been implemented on a UNIVAC 1100 series computer operating under EXEC 8 with a central memory that varies depending on input but never exceeds 65K of 36 bit words. For plotted output, a Stromberg-Carlson SC4020 plotter is required. The SINDA program was developed in 1971 with the fluid capability added in 1975. Adaptation of SINDA to the CDC computer was performed in 1978. The CDC Version has been implemented on a CDC CYBER 175 operating under NOS with a central memory requirement of approximately 175K (octal) of 60 bit words. SINDA is available by lease for a period of ten (10) years for a fee of $2,375.00 to domestic leasees. The leased program product includes the source code and supporting documentation. Additional documentation may be purchased separately at any time.

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

M79-10128 SDC/Integrated Services, Inc., McLean, Va.
BETA DISTRIBUTIONS: A COMPUTER PROGRAM FOR PROBABILITIES AND FRACTILE POINTS
FORTRAN IV 215 source statements
CDC 6000
FRC-11037 Price: Program/Documentation $25.00

Many practical problems in the physical and life sciences involve statistical considerations based on the BETA-distribution. Any BETA-distribution can be fully described by two range parameters and two shape parameters. This computer program was developed to calculate any desired probability and fractile point for any given BETA-distribution. Since the standard BETA-distribution is related to the F-distribution, this program can also be used to compute probabilities and fractile points for F-distributions. Additionally, routines are included for calculating density function and gamma function values for both integer and noninteger arguments. This program is written in FORTRAN 4 for batch execution and has been implemented on a CDC 6000 series machine with a central memory requirement of approximately 25K (octal) of 60 bit words. This BETA-distribution program was developed in 1978.

71 ACOUSTICS

Includes sound generation, transmission and attenuation.

For noise pollution see *45 Environment Pollution*.

M79-10127 Virginia Polytechnic Inst. and State Univ., Blacksburg.
NOIZ AND RAYTR: COMPUTER AIDED NOISE PREDICTION
FORTRAN IV 1,575 source statements
IBM 360
HQN-10947 Price: Program $810.00/Documentation $11.50

Concern for worker exposure to various noise sources makes noise level prediction an essential part of the design and planning of manufacturing and industrial facilities. The prediction of noise levels in acoustically complex rooms can be a tedious and troublesome task. The number of calculations required may be large and predictions based solely on the standard 'simple room acoustics' equations may be significantly in error. This software package contains two computer programs developed to aid the acoustical engineer in overcoming many of the problems usually associated with noise level prediction. One program, NOIZ, is

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an interactive system which is aimed primarily at allowing rapid calculation of predictions in rooms with many sources, many receivers, and moderately complex geometry. A modified room acoustics equation is used which approximately corrects for nonuniformity in the reverberant field. The other program, RAYTR, may be used to obtain a detailed prediction of noise levels in critical areas of the room. This program utilizes geometric acoustics and bases noise level predictions on actual sound transmission paths rather the reverberant field concepts. These programs should provide acoustical engineers with an accurate noise prediction capability. There are several shortcomings in the use of conventional diffuse room acoustics theory for predicting noise levels in factory spaces. The basic theory results in poor predictions for disproportionately shaped spaces, irregularly shaped spaces, and for space configurations where defraction of sound around corners is a significant factor. In the interactive program, the basic theory has been modified so that satisfactory prediction can be accomplished for a much more general range of space configurations, particularly those encountered in factories and industrial buildings. These modifications consist mainly of a correction for reverberant decay, a room coupling technique, and the inclusion of diffraction considerations. This program was developed as a user oriented interactive system so that engineers with little computer training and little background in acoustics theory can readily solve acoustics problems and predict noise levels during the design stage of a project. The program utilizes a question and answer format to prompt the user for all the required input data, and it displays the output in a clear and informative manner. The modified diffuse room acoustics theory has certain limitations. Much more detailed noise level studies can be achieved using geometric acoustics procedures. Unfortunately this detailed analysis requires a corresponding increase in invested computer resources, such as core requirements and run times. A geometric acoustics program was developed so that critical areas spotted by the simpler interactive program can be analyzed in greater detail. The program uses standard 'ray' trace techniques with the appropriate acoustical considerations. It can be used for enclosures with as many as 50 acoustically reflective surfaces, 50 noise sources, and 50 noise level receiver points. This program is run in the batch mode with the user supplying data concerning the geometry and acoustic properties of the room and noise sources. The sound pressure levels, both 'A' weighted and in octave bands, are calculated at each observer location specified. These two programs are written in FORTRAN 4 and have been implemented on an IBM 360 machine with a central memory requirement of approximately 260K of 8 bit bytes. The interactive program is intended for use under TSS but should be easily modified for use under TSO. These noise prediction programs were developed in 1978 by the Virginia Polytechnic Institute and State University with the support of the National Science Foundation.

72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure and molecular spectra.

M79-10128* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

CALCULATING AND FITTING THE VIBRATIONAL-ROTATIONAL ENERGY LEVELS OF INTERACTING VIBRATIONAL STATES

FORTRAN IV 1,783 source statements
UNIVAC 1100
NPO-14481 Price: Program $310.00/Documentation $9.50

The theoretical fit of the rotation-vibration energy levels of an asymmetric top molecule is often complicated by resonance effects arising from the proximity of levels belonging to different vibrational states. Consequently it is often necessary to fit the rotational energy levels of several vibrational states simultaneously, taking into account various vibration-rotation interactions. This computer program was developed to calculate and fit simultaneously the energy levels of any number of interacting vibrational states. Interactions up to fourth order terms in the Hamiltonian, including three kinds of Fermi-type interactions and three kinds of Coriolis-type interactions, have been accounted for. A Watson-type Hamiltonian with a maximum of twenty-nine parameters is used for the part of the Hamiltonian which is diagonal in the vibrational quantum numbers. This computer program is written in FORTRAN 4 for the batch execution and has been implemented on the UNIVAC 1100 with a central memory requirement of approximately 38K of 36 bit bytes. The program was developed in 1978.

81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

M79-10129* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

NASA PERT TIME 2 (IBM 370 VERSION)

FORTRAN IV (95 percent), OS ASSEMBLER (5 percent)
7,600 source statements
IBM 370
LEW-13145 Price: Program $920.00/Documentation $15.00

The planning and management of a large engineering project, where the interrelationships between activities and functional areas are numerous and involved, can become so complex that it is difficult to visualize as a whole. This potential problem readily lends itself to the employment of computerized data management systems. The Program Evaluation and Review Technique (PERT) is defined as a disciplined management technique involving computer processing. NASA PERT Time was developed as a computerized aid in the planning and control of project development variables, namely time and performance measurements. NASA PERT Time can give the project manager an insight into current and future project development, as well as forewarning of potential problem areas. A formalized evaluation and planning system cannot replace good management; therefore, the usefulness of NASA PERT Time 2 is entirely dependent on analysis and judgement by the project manager. NASA PERT Time 2 can prove to be a very valuable aid offering the project manager a better overview of the project as a whole. The NASA PERT Time 2 program utilizes a modular technique. The module for computer system requirements is called a subnet; it is a subset or portion of a project network's activities. The program user will usually see this module as a fragnet. A fragnet is defined as a meaningful portion of a project network. There is no significant difference between a subnet and a fragnet. A fragnet allows the user to represent project entities such as a subdivision of work, a contractor, an organization, a mission, a summary, or an intergration network. Each fragnet will contain some events which are identical to events in other fragnets which make up the project network. These events are defined as interface events and identify the relations between fragnets. Once all aspects of a project have been described in terms of fragnets, a control network is automatically generated. This control network is made up of control activities obtained by condensing all paths between control network events. Control network events are made up of interface events and all start and end events. The program determines both expected and allowed dates for each control network event. Finally, the program generates reports on expected and allowed activity dates for fragnets specified by the user. As a project progresses, event and time variables in the fragnets and control network may be updated and new reports generated. There are no well-defined limits on the size of the project which may be analyzed. The size of the project which may be analyzed depends mainly on the computer resources available and the level of detail used in the fragnets. The program is currently designed to handle a maximum of 50 fragnets with each fragnet containing a maximum of 2,160 activities, 2,000 events and 500 starts, ends, and interfaces. This program is written in FORTRAN 4 and OS ASSEMBLER for batch execution and has been implemented on an IBM 370 with a minimum central memory requirement of approximately 350K of 8 bit

bytes. The original NASA PERT Time 2 program was developed in 1965 for use on the IBM 7094 and was adapted for use on the IBM 370 in 1979.

M79-10130* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MBASIC PROCESSOR
ASSEMBLER 20,000 source statements
PDP Dec-10
NPO-14245 Price: Program $1590.00/Documentation $39.50

MBASIC, and advanced version of the BASIC language developed at Dartmouth College, is a high-level interactive computer language designed to minimize the time required for a user to program a task for computer execution. MBASIC, like BASIC and FORTRAN, combines English and simple algebra to give instructions to the computer; however, MBASIC results in shorter programs of simpler structure which are easier to write and understand than the other two languages. In addition, practically all system commands needed for management information processing are available in MBASIC. This feature makes it unncessary for MBASIC users to learn executive commands or to rewrite MBASIC programs to accommodate system changes. MBASIC should provide a powerful computing language for technical or management information processing and for scientific and engineering applications. The conversational nature of MBASIC allows the user to interact with the program as it is being developed. Each MBASIC statement is analyzed for errors as it is entered. Diagnostic error messages and versatile editing features enable the user to make corrections quickly and easily. Any portion of a program may be executed before it is completely assembled. This ability is one of the fundamental design features of MBASIC and the principal reason why MBASIC has truly conversational capabilities. Although individual statements may be syntactically correct, erroneous expressions can cause an interruption during program execution. If an interruption occurs, a diagnostic message is printed and control returned to the user. If necessary, the user may enter direct statements and execute them immediately. After program corrections have been made, execution can be resumed at any appropriate statement, including the statement in which the interruption occurred. The power of MBASIC lies in its capacity to direct a computer to perform a large variety of complex tasks while requiring the user to supply a minimum number of simple English or algebraic instructions. The program instructions are written like sentences, resulting in a program that is easy to read and write. These instructions are combined into program modules that are written like paragraphs. Comments may be included to document module functions. The outstanding features that contribute to the power of MBASIC include: multiple assignments in a single instruction; conditional, assignment, and repetitive statement modifiers; multiple modified statements in a single instruction; and excellent string handling capabilities. Excellent array handling capabilities are available, including assigning values while dimensioning, matrix algebra written like simple algebra, and combining simple and array expressions in a single instruction. The programmer may use expressions to refer to statement numbers and access magnetic tapes through terminal devices during program execution. The availability of these and other features leads naturally to a simplification of the program design process. Two machine versions of the MBASIC processor are available, UNIVAC and DEC-10. The UNIVAC version is written in ASSEMBLER for interactive execution under EXEC 8 and has a central memory requirement of approximately 28K of 36 bit words. Each user requires approximately 49K to access the reentrant processor. The UNIVAC MBASIC processor was developed in 1973. In 1977, an MBASIC processor was developed for use on the PDP DEC-10. The DEC-10 version is written in ASSEMBLER for interactive execution. MBASIC is a trademark of the California Institute of Technology.

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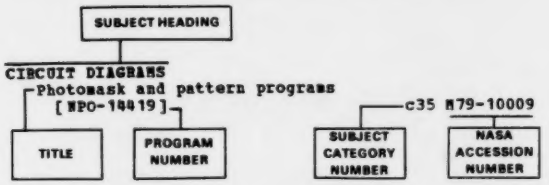

The subject heading is a key to the subject content of the document. The titles, with title extensions if present, are arranged under each subject heading in ascending accession number order. The program number is the number assigned in the COSMIC inventory to identify the coded source. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category.

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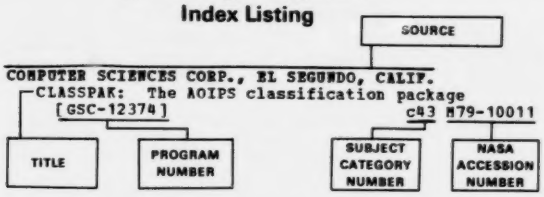

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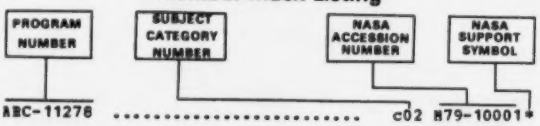

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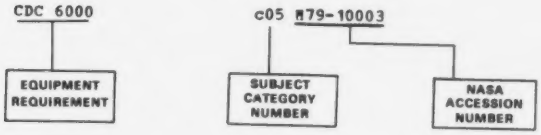

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INTRODUCTION

Computer Program Abstracts is an indexed journal containing abstracts of documented computer programs developed by the National Aeronautics and Space Administration, NASA contractors, and other Federal Agencies, which are offered for sale through the NASA sponsored Computer Software Management and Information Center (COSMIC) located at the University of Georgia.

Computer Program Abstracts is published quarterly by the National Aeronautics and Space Administration and is organized into five sections. The first section contains program citations and abstracts arranged in ten major divisions divided into seventy-four specific subject categories and one general category/division. Following are four sections of indexes: subject, originating source, program number/accession number, and equipment requirements.

The Subject Index is an alphabetical listing of the main subject headings by which the computer programs have been identified.

The Originating Source Index is an alphabetical listing of the names of organizations responsible for the computer programs contained in the journal.

The Program Number/Accession Number Index provides a cross-index from the program number assigned in the COSMIC inventory to identify coded source and sequence to the corresponding accession number assigned sequentially to abstracts in *Computer Program Abstracts*.

The Equipment Requirements Index comprises an alphanumeric listing of the kinds of equipment required for the use of the computer programs included in the journal.

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02 AERODYNAMICS 1

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For related information see also *34 Fluid Mechanics and Heat Transfer*.

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06 AIRCRAFT INSTRUMENTATION N.A.

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07 AIRCRAFT PROPULSION AND POWER N.A.

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion*.

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17 SPACECRAFT COMMUNICATIONS, COMMAND AND TRACKING N.A.

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18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE 2

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For life support systems see *54 Man/System Technology and Life Support*. For related information see also *05 Aircraft Design, Testing and Performance* and *39 Structural Mechanics*.

19 SPACECRAFT INSTRUMENTATION **N.A.**

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography*.

20 SPACECRAFT PROPULSION AND POWER **N.A.**

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion*.

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

23 CHEMISTRY AND MATERIALS (GENERAL) **N.A.**

Includes biochemistry and organic chemistry.

24 COMPOSITE MATERIALS **N.A.**

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25 INORGANIC AND PHYSICAL CHEMISTRY **3**

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

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26 METALLIC MATERIALS **3**

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

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28 PROPELLANTS AND FUELS **N.A.**

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

For related information see also *Physics*.

31 ENGINEERING (GENERAL) **3**

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32 COMMUNICATIONS **N.A.**

Includes land and global communications; communications theory; and optical communications.

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46 GEOPHYSICS **N.A.**

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47 METEOROLOGY AND CLIMATOLOGY **N.A.**

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48 OCEANOGRAPHY **N.A.**

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LIFE SCIENCES

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53 BEHAVIORAL SCIENCES **N.A.**

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT **N.A.**

Includes human engineering; biotechnology; and space suits and protective clothing.

55 PLANETARY BIOLOGY **N.A.**

Includes exobiology; and extraterrestrial life.

MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL) **N.A.**

60 COMPUTER OPERATIONS AND HARDWARE **6**

Includes computer graphics and data processing.

For components see *33 Electronics and Electrical Engineering*.

61 COMPUTER PROGRAMMING AND SOFTWARE **N.A.**

Includes computer programs, routines, and algorithms.

62 COMPUTER SYSTEMS **N.A.**

Includes computer networks.

63 CYBERNETICS **N.A.**

Includes feedback and control theory.

For related information see also *54 Man/System Technology and Life Support*.

64 NUMERICAL ANALYSIS **7**

Includes iteration, difference equations, and numerical approximation.

65 STATISTICS AND PROBABILITY **N.A.**

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

66 SYSTEMS ANALYSIS **N.A.**

Includes mathematical modeling; network analysis; and operations research.

67 THEORETICAL MATHEMATICS **N.A.**

Includes topology and number theory.

PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

For related information see also *Engineering*.

70 PHYSICS (GENERAL) **N.A.**

For geophysics see *46 Geophysics*. For astrophysics see *90 Astrophysics*. For solar physics see *92 Solar Physics*.

71 ACOUSTICS **N.A.**

Includes sound generation, transmission, and attenuation.

For noise pollution see *45 Environment Pollution*.

72 ATOMIC AND MOLECULAR PHYSICS **N.A.**

Includes atomic structure and molecular spectra.

73 NUCLEAR AND HIGH-ENERGY PHYSICS **N.A.**

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation*.

74 OPTICS **N.A.**

Includes light phenomena.

75 PLASMA PHYSICS **N.A.**

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

76 SOLID-STATE PHYSICS **N.A.**

Includes superconductivity.

For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers*.

77 THERMODYNAMICS AND STATISTICAL PHYSICS **N.A.**

Includes quantum mechanics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer*.

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

80 SOCIAL SCIENCES (GENERAL) **N.A.**

Includes educational matters.

81 ADMINISTRATION AND MANAGEMENT **N.A.**

Includes management planning and research.

82 DOCUMENTATION AND INFORMATION SCIENCE **N.A.**

Includes information storage and retrieval technology; micrography; and library science.

For computer documentation see *61 Computer Programming and Software*.

83 ECONOMICS AND COST ANALYSIS **N.A.**

Includes cost effectiveness studies.

84 LAW AND POLITICAL SCIENCE **N.A.**

Includes space law; international law; international cooperation; and patent policy.

85 URBAN TECHNOLOGY AND TRANSPORTATION **N.A.**

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see *03 Air Transportation and Safety*, *16 Space Transportation*, and *44 Energy Production and Conversion*.

SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

For related information see also *Geosciences*.

88 SPACE SCIENCES (GENERAL) **N.A.**

89 ASTRONOMY **N.A.**

Includes radio and gamma-ray astronomy; celestial mechanics; and astrometry.

90 ASTROPHYSICS **N.A.**

Includes cosmology; and interstellar and interplanetary gases and dust.

91 LUNAR AND PLANETARY EXPLORATION **N.A.**

Includes planetology; and manned and unmanned flights.

For spacecraft design see *18 Spacecraft Design, Testing and Performance*. For space stations see *15 Launch Vehicles and Space Vehicles*.

92 SOLAR PHYSICS **N.A.**

Includes solar activity, solar flares, solar radiation and sunspots.

93 SPACE RADIATION **7**

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

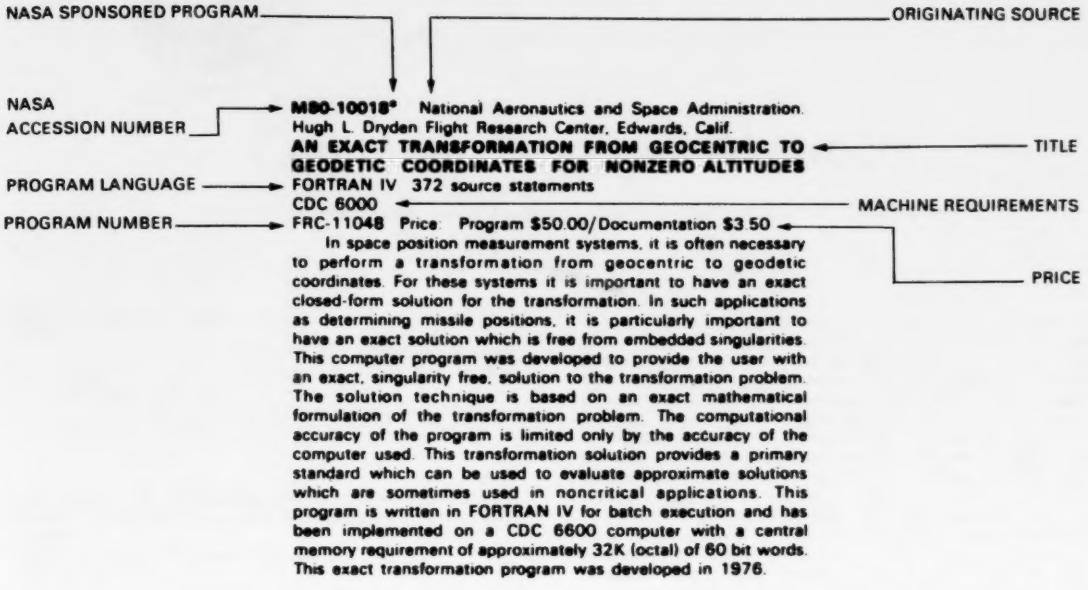
GENERAL

99 GENERAL **N.A.**

Note: N.A. means that no abstracts were assigned to this category for this issue.

SUBJECT INDEX I-1
ORIGINATING SOURCE INDEX I-5
PROGRAM NUMBER/ACCESSION NUMBER INDEX I-7
EQUIPMENT REQUIREMENTS INDEX I-9

TYPICAL CITATION AND ABSTRACT


NASA SPONSORED PROGRAM
ORIGINATING SOURCE
NASA ACCESSION NUMBER
MSC-10018* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
AN EXACT TRANSFORMATION FROM GEOCENTRIC TO GEODETIC COORDINATES FOR NONZERO ALTITUDES
TITLE
PROGRAM LANGUAGE
FORTRAN IV 372 source statements
CDC 6000
MACHINE REQUIREMENTS
PROGRAM NUMBER
FRC-11048 Price: Program $50.00/Documentation $3.50
PRICE
In space position measurement systems, it is often necessary to perform a transformation from geocentric to geodetic coordinates. For these systems it is important to have an exact closed-form solution for the transformation. In such applications as determining missile positions, it is particularly important to have an exact solution which is free from embedded singularities. This computer program was developed to provide the user with an exact, singularity free, solution to the transformation problem. The solution technique is based on an exact mathematical formulation of the transformation problem. The computational accuracy of the program is limited only by the accuracy of the computer used. This transformation solution provides a primary standard which can be used to evaluate approximate solutions which are sometimes used in noncritical applications. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6600 computer with a central memory requirement of approximately 32K (octal) of 60 bit words. This exact transformation program was developed in 1976.

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Computer Program Abstracts

A Quarterly Publication of the National Aeronautics and Space Administration

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

MSC-10001 Rockwell International Corp., Los Angeles, Calif.
APAS: AERODYNAMIC PRELIMINARY ANALYSIS SYSTEM
FORTRAN IV 17,489 source statements
CDC CYBER 70
LAR-12404 Price: Program $1900.00/Documentation $27.00

The computerization of aerodynamic theory has progressed to a state where the analysis of complete aircraft configurations can be performed by a single program. Currently existing programs of this nature abound with subtleties and difficulties attributable to the level of precision of the underlying theory and the sensitivity of the associated numerical solution techniques. In preliminary design stages, it is often desirable to accept some degree of approximation in the interest of faster turn-around, reduced computational costs, simplification of input, and stability of results while maintaining generality. The Aerodynamic Preliminary Analysis System, APAS, was developed as a comprehensive aerodynamic analysis system based on linearized potential theory. Three dimensional configurations, with or without jet flaps, having multiple nonplanar surfaces of arbitrary planeform and open or closed slender bodies of noncircular contour may be analyzed with the APAS system. As a preliminary design aid, APAS allows the designer to systematically survey a large number of alternative configurations and component geometries economically. APAS, when combined with realistic assessments of its limitations and estimated viscous characteristics, provides a valuable tool for analyzing general aircraft configurations and aerodynamic interactions. The analysis technique employed by APAS is based on linearized aerodynamic theory. The configuration to be analyzed is simulated by a distribution of source and vortex singularities. Each of the singularities satisfies the linearized small perturbation potential equation of motion. The singularity strengths are obtained by satisfying the condition that the flow remains tangent to the local surface. The bodies, interference shells, and aerodynamic surfaces are each simulated by different types of singularities. First the strengths of singularities representing the fuselage and nacelles are determined by using a slender body thickness approach to predict the surface and near field properties. Perturbation velocities induced on the aerodynamic surfaces are evaluated. Singularity strengths representing aerodynamic surfaces are determined utilizing thin airfoil panel theory which allows the effects of thickness and lift to be considered independently. A cylindrical, noncircular, interference shell, composed entirely of vortex panels, is used to account for the interference effects of the aerodynamic surfaces on the fuselage and nacelles. Once all of the singularity strengths are determined, the resulting velocities and pressures throughout the flow are obtained. APAS also performs a drag analysis for determining skin friction, potential form drag, and trim drag. APAS was developed as a user oriented interactive system. Once the system is accessed, the analyst is in a self contained interactive environment wherein he can input vehicle definitions, perform aerodynamic analysis, and display computed results without exiting the system. Geometry and analysis data may be saved for later sessions and is protected from loss due to machine failure. The interactive nature of APAS permits the analyst to readily train himself in the use of the system. The APAS system is written in FORTRAN IV for interactive, or batch, execution and has been implemented on a CDC CYBER 175 computer. The largest program in the APAS system has a central memory requirement of approximately 120K (octal) of 60 bit words. The computer on which APAS is installed must support segmentation and random access files. The interactive and graphics capabilities of APAS require a Tektronix 4014 graphics terminal, a Tektronix 4096 graphics tablet, and the Tektronix Plot-10 and Graphics Tablet support. The APAS system was developed in 1978.

MSC-10002* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
RAXBOD: A FORTRAN PROGRAM FOR INVISCID TRANSONIC FLOW OVER AXISYMMETRIC BODIES
FORTRAN IV 1,823 source statements
CDC 6000
LAR-12499 Price: Program $460.00/Documentation $15.50

The problem of axisymmetric transonic flow is of interest not only because of the practical application to missile and launch vehicle aerodynamics, but also because of its relation to fully three dimensional flow in terms of the area rule. The RAXBOD computer program was developed for the analysis of steady, inviscid, irrotational, transonic flow over axisymmetric bodies in free air. RAXBOD uses a finite difference relaxation method to numerically solve the exact formulation of the disturbance velocity potential with exact surface boundary conditions. Agreement with available experimental results has been good in cases where viscous effects and wind tunnel wall interference are not important. The governing second-order partial differential equation describing the flow potential is replaced by a system of finite difference equations, including Jameson's rotated difference scheme at supersonic points. A stretching is applied to both the normal and tangential coordinates such that the infinite physical space is mapped onto a finite computational space. The boundary condition at infinity can be applied directly and there is no need for an asymptotic far-field solution. The system of finite difference equations is solved by a column relaxation method. In order to obtain both rapid convergence and any desired resolution, the relaxation is performed iteratively on successively refined grids. Input to RAXBOD consists of a description of the body geometry, the free stream conditions, and the desired resolution control parameters. Output from RAXBOD includes computed geometric parameters in the normal and tangential directions, iteration history information, drag coefficients, flow field data in the computational plane, and coordinates of the sonic line. This program is written in FORTRAN IV for batch execution and has been implemented

on a CDC 6600 computer with an overlayed central memory requirement of approximately 40K (octal) of 60 bit words. Optional plotted output can be generated for the Calcomp plotting system. The RAXBOD program was developed in 1976.

M80-10003* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DONBOL: A COMPUTER PROGRAM FOR PREDICTING AXISYMMETRIC NOZZLE AFTERBODY PRESSURE DISTRIBUTIONS AND DRAG AT SUBSONIC SPEEDS
FORTRAN IV 3,222 source statements
CDC 6000
LAR-12619 Price: Program $650.00/Documentation $24.00

The drag producing components of an airplane propulsion system are usually installed in areas where the flow field is extremely complex. High body slopes and long boundary layer runs, especially in the afterbody nozzle region, result in strong viscous effects on the boattail drag. The viscous nature of the jet exhaust plume further complicates the flow in this region. Because of these strong viscous interactions, most methods used for predicting the installed propulsion system drag are limited to empirical techniques. The DONBOL computer program was developed to analytically predict the axisymmetric nozzle afterbody pressure distributions and drag. The DONBOL program predictions are based on a Neumann solution for inviscid external flow coupled with a modified Reshotko-Tuker integral boundary layer technique, the control volume method of Prez for calculating flow in the separated region, and an inviscid one dimensional solution for the jet exhaust flow. Comparisons with experimental data indicate that the program accurately predicts the pressure distributions of boattail afterbodies for which the jet exhaust plume can be simulated by a solid body. For other configurations, the nozzle pressure drag seems to be significantly underpredicted. This method is limited to subsonic free stream Mach numbers below that for which the flow over the body becomes sonic. The DONBOL program is based on the assumption that the flow is composed of a viscous layer near the body, an inviscid external flow, and, if present, an inviscid jet exhaust flow. A Neuman solution for incompressible flow, along with a compressibility correction, is used to determine the inviscid external flow. The inviscid boundary of the jet exhaust flow is calculated based on one dimensional isentropic flow theory. Properties of the viscous boundary layer, both attached and separated, and the location of any separation on the nozzle boattail are calculated using the method of Presz, King, and Bateau. The concept of a discriminating streamline is used to avoid singularities in the boundary layer calculations. However, the boundary layer displacement thickness, the discriminating streamline shape, and the inviscid jet boundary are functions of the pressure distribution along the body and the jet boundary. The final flow solution is obtained by iterating between the inviscid outer flow solution, the inviscid jet plume solution, and the viscous boundary layer solution until a specified degree of convergence occurs. Input to the DONBOL program includes body geometry, solution control parameters, free-stream conditions, and jet exhaust conditions. Output includes detailed information on the iterative calculations of the flow field. This program is written in FORTRAN IV for batch execution on a CDC 6600 computer and has an overlayed central memory requirement of approximately 76K (octal) of 60 bit words. The DONBOL program was developed in 1979.

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics.*

M80-10004* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
OPTIMAL AIRCRAFT TRAJECTORIES FOR SPECIFIED RANGES
FORTRAN IV 2,583 source statements
CDC 6000
ARC-11282 Price: Program $590.00/Documentation $17.50

For an aircraft operating over a fixed range, the operating costs are basically a sum of fuel cost and time cost. While minimum fuel and minimum time trajectories are relatively easy to calculate, the determination of a minimum cost trajectory can be a complex undertaking. This computer program was developed to optimize trajectories with respect to a cost function based on a weighted sum of fuel cost and time cost. As a research tool, the program could be used to study various characteristics of optimum trajectories and their comparison to standard trajectories. It might also be used to generate a model for the development of an airborne trajector optimization system. The program could be incorporated into an airline flight planning system, with optimum flight plans determined at takeoff time for the prevailing flight conditions. The use of trajectory optimization could significantly reduce the cost for a given aircraft mission. The algorithm incorporated in the program assumes that a trajectory consists of climb, cruise, and descent segments. The optimization of each segment is not done independently, as in classical procedures, but is performed in a manner which accounts for interaction between the segments. This is accomplished by the application of optimal control theory. The climb and descent profiles are generated by integrating a set of kinematic and dynamic equations, where the total energy of the aircraft is the independent variable. At each energy level of the climb and descent profiles, the air speed and power setting necessary for an optimal trajectory are determined. The variational Hamiltonian of the problem consists of the rate of change of cost with respect to total energy and a term dependent on the adjoint variable, which is identical to the optimum cruise cost at a specified altitude. This variable uniquely specifies the optimal cruise energy, cruise altitude, cruise Mach number, and, indirectly, the climb and descent profiles. If the optimum cruise cost is specified, an optimum trajectory can easily be generated; however, the range obtained for a particular optimum cruise cost is not known a priori. For short range flights, the program iteratively varies the optimum cruise cost until the computed range converges to the specified range. For long-range flights, iteration is unnecessary since the specified range can be divided into a cruise segment distance and full climb and descent distances. The user must supply the program with engine fuel flow rate coefficients and an aircraft aerodynamic model. The program currently includes coefficients for the Pratt-Whitney JT8D-7 engine and an aerodynamic model for the Boeing 727. Input to the program consists of the flight range to be covered and the prevailing flight conditions including pressure, temperature, and wind profiles. Information output by the program includes: optimum cruise tables at selected weights, optimal cruise quantities as a function of cruise weight and cruise distance, climb and descent profiles, and a summary of the complete synthesized optimal trajectory. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6000 series computer with a central memory requirement of approximately 100K (octal) of 60 bit words. This aircraft trajectory optimization program was developed in 1979.

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes spacecraft thermal and environmental control; and attitude control.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance* and *39 Structural Mechanics.*

M80-10005 Northrop Services, Inc., Huntsville, Ala.
IUS SPIN STAGE SIX DEGREE OF FREEDOM SIMULATION
FORTRAN IV 825 source statements
UNIVAC 1100
MFS-25206 Price: Program $140.00/Documentation $6.00

For some interplanetary missions, the upper stages of the spacecraft will not have guidance or control reaction systems. To enhance the accuracy of trajectory injection, the spacecraft can be spun about its principal thrust axis, in the desired attitude, prior to ignition of the rocket motor. Any change in attitude during the rocket burn will degrade the accuracy of injection into the desired trajectory. This computer program was developed to simulate, as a full six degree of freedom problem, the spinning spacecraft during the rocket motor burn. This simulation can be used to estimate the accuracy loss which will occur during trajectory injection. The simulation includes the effects of: thrust buildup and decay, thrust misalignment, changing mass, changing center of gravity, changing principal moments of inertia and their derivatives, changing cross products of inertia and their derivatives, jet damping effects, and an oblate gravity model. The spin rate and attitude modeling uses the method of quarternions so that renormalization can be accomplished as necessary. The simulation has been tailored to the Inertial Upper State (IUS) vehicle with solid rocket motors but could be useful in simulating other spacecraft configurations. This program is written in FORTRAN IV for batch execution and has been implemented on a UNIVAC 1108 computer with a central memory requirement of approximately 11K of 36 bit words. This program was developed in 1979.

25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics*.

M80-10006 Concentration Heat and Momentum Ltd., London (England).
PREDICTION OF HYDRODYNAMICS AND CHEMISTRY OF CONFINED TURBULENT METHANE-AIR FLAMES IN A TWO-CONCENTRIC-TUBE COMBUSTOR
FORTRAN IV 3,366 source statements
UNIVAC 1100
LEW-13388 Price: Program $650.00/Documentation $22.00

A better understanding of the combustion process could lead to the design of combustors which are more efficient and less polluting. This computer program was developed to provide for the realistic modeling of the hydrodynamics and chemical reactions which occur in a reverse flow two-concentric-tube combustor. Special attention is given to predicting the concentrations of the oxides of nitrogen which are formed. The predictions obtained from the program could aid the combustion engineer in developing a better understanding of the combustion process. The combustor geometry considered is a two-concentric-tube combustor. Concentric streams of gaseous fuel (methane) and air enter the inner duct and mix. At the end of the inner duct, the flow expands radially outward and flow reversal occurs into the outer duct. Combustion is assumed to occur in this flow reversal region. The governing differential equations for steady, two dimensional axisymmetric fluid flow are solved using a finite difference technique. A chemical equilibrium model is included to characterize the hydrocarbon oxidation reactions which occur in the combustion zone. The oxides of nitrogen formed are considered separately from the equilibrium species since there formation is governed by much slower kinetically controlled reactions. Concentration of these pollutant species is determined by a chemical kinetics model. The user supplies data describing the combustor sizing, thermochemical properties, and reaction mechanisms. Program output includes profiles of velocity, temperature, and chemical species concentration throughout the combustor. This program is written in FORTRAN IV for batch execution and has been implemented on a UNIVAC 1100 computer with a central memory requirement of approximately 33K of 36 bit words. This combustor analysis program was developed in 1978.

26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

M80-10007* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DBASE1: EXACT SOLUTIONS FOR DIFFUSION IN SINGLE PHASE BINARY ALLOY SYSTEMS WITH PLANAR, CYLINDRICAL, OR SPHERICAL INTERFACES
FORTRAN IV 440 source statements Prepared in cooperation with Virginia Polytechnic Inst., Blacksburg
CDC 6000
LAR-12665 Price: Program $340.00/Documentation $11.50

In the analysis of diffusion controlled processes, one must have the ability to predict the degree of interaction between different components for a given set of exposure equations. Except in limited cases where analytical solutions exist, the diffusion equation, with appropriate initial and boundary conditions, is usually solved by finite-difference methods. The DBASE1 computer program was developed to provide the analyst with a set of simple algorithms for exact solutions of diffusion in single phase binary alloy systems with planar, cylindrical, or spherical interfaces. This exact solution approach typically takes much less time than the commonly used finite difference calculations. Two algorithms are provided for each of the three interface geometries. One algorithm is designed to converge rapidly for short diffusion times, while the other algorithm converges rapidly for long diffusion times. For planar geometry, the long time algorithm is a trigonometric solution, and the short time algorithm is the classical double error function solution generalized to account for the extra multiple reflections. For cylindrical geometry, the long term algorithm is based on Bessel functions and roots of Bessel equations. The short time algorithm involves integration, using a Gauss-Legendre quadrature, over a modified Bessel function. For spherical geometry, the long time algorithm is based on roots of trigonometric equations, while the short time algorithm involves error functions. Utilization of these algorithms in the DBASE1 program, along with an established methodology for selecting the appropriate algorithm for a given situation, can provide the analyst with a rapid solution to diffusion problems. The DBASE1 program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6600 computer with a central memory requirement of approximately 33K (octal) of 60 bit words. The DBASE1 program was developed in 1979.

31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; and cryogenics.

M80-10008 Naval Ship Research and Development Center, Bethesda, Md.
SSDP: STRUCTURAL SYNTHESIS DESIGN PROGRAM
FORTRAN IV 11,216 source statements
CDC 6000
DOD-00067 Price: Program $1000.00/Documentation $39.50

The structural design of a large naval ship involves a complex series of tradeoffs aimed at achieving minimum weight with maximum structural strength. The Naval Ship Research and Development Center (NSRDC) has played an important role in the development of computerized techniques for automated ship design. The Structural Synthesis Design Program (SSDP) represents a significant extension of the original MIDSHIP program developed by NSRDC for designing longitudinal scantlings for midship sections. SSDP may be used to design the longitudinal scantlings for a variety of ship cross sections consisting of any practical combination of decks, platforms, bulkheads, and materials. The scantlings designed by SSDP comply with the design criteria defined by current U. S. Navy design practices. SSDP may also be used to validate the design of a ship section

by analyzing selected scantlings. SSDP synthesizes a section design such that it will be in compliance with specified strength criteria. The user supplies SSDP with data on the basic geometry of the section, assumed primary hull-grider stresses, secondary loads, plate and beam materials, range of beam spacings to be investigated, and other related data. SSDP determines an initial set of longitudinal scantlings for the section. This initial design is the minimum weight section capable of withstanding the constant secondary loadings and the assumed primary hull-girder stresses. Actual primary stresses are determined and used as assumed stresses to synthesize refined scantlings. Refinement of the scantlings continues until the actual and the assumed stresses match to within a specified tolerance. Once a stress consistent design is achieved, SSDP checks for adequate hill-girder strength. If the calculated primary stress at either the upper deck or the keel exceeds the primary stress limit, additional material is added at the appropriate locations. After the material additions are made, the entire process is repeated until scantlings are determined which are structurally adequate and have a minimum weight. The SSDP output includes detailed data on the scantlings, stresses, and section at each iteration. The final scantlings generated by SSDP can be used to develop typical section drawings, including material specifications, and longitudinal scantlings. This information should be useful in determining the structural feasibility of a proposed design and in providing guidance in developing longitudinal weight estimates. The SSDP program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6600 computer with a central memory requirement of approximately 215K (octal) of 60 bit words. SSDP can generate section plot data for display on the SC-4020 plotting system. The SSDP program was developed in 1977.

M80-10009 Naval Ship Engineering Center, Washington, D. C.
HULGEN: SHIP HULL GENERATOR
FORTRAN IV (99 percent); COMPASS (1 percent) 6,721 source statements
CDC 6000
DOD-00071 Price: Program $680.00/Documentation $24.00

The procedures, calculations, and graphics traditionally used in manually obtaining a ship hull form are tedious and time consuming. Since the designer usually would like to produce and compare numerous variations of the hull form, this manual production method can become a bottleneck in the design process. The Naval Ship Engineering Center has developed a computer program, HULGEN, which utilizes interactive computer graphics to perform its task as an automated ship hull form generator. HULGEN processing closely follows the techniques used in manual hull generation, thus making use of the program easily mastered by those who have used the manual method. The increased throughput possible with HULGEN and the interactive environment allow the designer to consider numerous variations of the hull forms in a relatively short period of time. HULGEN can be used during feasibility and concept design stages to satisfy the need for rapid, approximate depiction of hull forms having specific hull form parameters. Given the minimum input of length, beam, draft, prismatic and midship section coefficients, LCB, LCF, and main deck at edge profile, HULGEN computes all of the parameters and control curves. From this data, the program generates and displays an initial body plan. The body plan thus generated may not be the final one desired by the naval architect but the procedure eliminates the need for making initial estimates. The control curves produced include section area, load water line, main deck at edge, flat of bottom, keel rise, sheer, and slopes for the body plan sections. The naval architect can selectively change one or more of these curves to develop the hull from desired. The hull form is stretched and distorted into shapes which meet the variations desired while maintaining the established hull form parameters. The HULGEN program is written in FORTRAN IV and COMPASS for interactive execution and has been implemented on a CDC 6600 computer with a central memory requirement of approximately 67K (octal) of 60 bit words. The interactive graphics capabilities require a Tektronix 4014/15 Storage Tube terminal and the Tektronix Plot-10 software system. The HULGEN program was developed in 1978.

M80-10010 CADCOM, Inc., Annapolis, Md.
UPLOTE: A TWO-DIMENSIONAL DRAFTING SYSTEM EDITOR
FORTRAN IV (99.9 percent); COMPASS (.1 percent) 11,439 source statements
CDC 6000
DOD-00072 Price: Program $1150.00/Documentation $11.00

The bottleneck for many engineering design projects is the drafting department. The production of the initial set of engineering drawings can often require many long hours of manual labor at the drafting table. Major changes in the design may require that the entire set of drawings be redrawn. The advent of sophisticated, interactive computer graphics equipment has made it possible for much of the manual drudgery to be eliminated from the task of generating and maintaining engineering drawings. The UPLOTE computer program was developed to provide the user with a general purpose automated drafting system capable of producing and editing two dimensional engineering drawings of any type. The UPLOTE program has been utilized by the U.S. Navy to produce engineering drawings related to ship systems such as piping, heating, ventilation, air conditioning, and electrical networks. Besides increasing the productivity of draftsmen, the UPLOTE drafting system editor provides the user with the capability to store engineering drawings on a secure and computer accessible medium such as magnetic tape or disk. UPLOTE provides the user with a sophisticated, CRT display based, interactive drafting and editing system. The program is designed to initially read card images representing the graphic entities to be drawn. This data includes graphics cards for defining lines and curves, as well as initialization cards specifying drawing scales and coordinate systems. Through interactive commands this initial data file may be plotted or 'edited'. The editing capabilities of this system include: zooming in on a specified portion of a large drawing, deleting items in the data file, adding text or predefined templates to the data file, moving and rotating items with respect to the complete drawing, and inserting symbols into existing parts of the drawing. An edited drawing may be stored on disk, plotted on a hard copy device in its entirety or any portion thereof, or discarded. When the user has satisfactorily modified the drawing, the modifications may be incorporated into the original data file. The UPLOTE program is written in ANSI FORTRAN IV, and one small COMPASS routine, for interactive execution. The program has been implemented on a CDC 6000 computer with a central memory requirement of approximately 108K (octal) of 60 bit words. The UPLOTE program requires a Tektronix 4015-1 CRT and the Tektronix PLOT-10 graphics software system. UPLOTE was developed in 1978.

34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics*.

M80-10011* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COMPUTER PROGRAMS FOR CALCULATING TWO-DIMENSIONAL POTENTIAL FLOW IN AND ABOUT PROPULSION SYSTEM INLETS
FORTRAN V 9,133 source statements
UNIVAC 1100
LEW-13278 Price: Program $700.00/Documentation $19.00

This package consists of three computer programs developed for calculating two dimensional potential flow in and about propulsion system inlets. Since the capability for a full three dimensional inlet analysis does not currently exist, simpler but approximate methods for modeling inlets have to be employed. There are several programs available to model axisymmetric inlets, but shapes such as scoop inlets and dual inlets are not adequately modeled by axisymmetric methods. These two shapes are

better modeled by two dimensional techniques. Vertical and short field takeoff and landing aircraft require propulsion systems that operate efficiently over wide ranges of free stream velocity, incidence angle, and Mach number of flow through the inlet. A major factor determining the efficiency of operations over this wide range of conditions is the design of the propulsion system inlet. This group of programs forms a useful tool to analyze inlet flow and test various inlet geometries for efficiency. To analyze the two dimensional potential flow in and about propulsion system inlets, the compressible, or incompressible, potential flow must be known for any combination of operating conditions of free stream velocity, inlet incidence angle, and inlet mass flow rate. A program called SCIRL is used to generate the geometric representation of the inlet. SCIRL input includes points, line segments, and the type of curve to use between points. At least one set of points, rake points, in a plane perpendicular to the axis of the inlet is required at the location where the inlet weight flow is specified. Rake points must be specified at each location where velocity profiles or streamlines are desired. A maximum of 25 sets of rake points may be specified. Output from SCIRL consists of information on the inlet shape and a plot of the inlet. Program 23Y uses output from SCIRL to determine basic solutions to the two dimensional flow problem. Program COMBINE-2D combines the basic solutions, applies the compressibility correction of Lieblien-Stockmand, and performs a supersonic correction for cases when the velocity on the inlet surface is locally supersonic. COMBIN-2D provides tabular and plotted output of the Mach number distribution on the inner and outer surfaces of the inlet and the vector flow field both inside and outside the inlet. This program package is written in FORTRAN V for batch execution and has been implemented on a UNIVAC 1100 series computer operating under EXEC 8 with a central memory requirement of approximately 61K of 36 bit words. Plotted output is generated for the CALCOMP plotting system. This program package was developed in 1977.

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance*.

MSC-10012 Army Aviation Research and Development Command, Hampton, Va.

POCD: PREDICTION OF CRACK AND DEBOND GROWTH IN A CRACKED METAL SHEET REINFORCED WITH COMPOSITE

FORTRAN IV 1,592 source statements
CDC CYBER 70
LAR-12696 Price: Program $310.00/Documentation $3.50

Under cyclic loads, a metal sheet reinforced with composite will exhibit both cracking and debonding. The crack and debond growth which occurs in these reinforced systems is significantly different from crack growth in a homogeneous medium. The Prediction of Cracking and Debonding (POCD) program was developed to analytically predict both the crack growth and the debond growth in composite reinforced metal sheet in which cracking is already present. The program employs a complex variable formulation of Green's functions for cracked isotropic sheets and uncracked orthotropic sheets to calculate inplane and interlaminar stresses, stress intensities, and strain energy release rates. Input consists of sheet physical characteristics, applied stresses, initial crack description, and crack growth conditions. For realistic modeling, stresses are calculated for both the adhesives and the adherents. These stress intensities are used to predict crack growths and the strain energy release rates are used to predict debond growth. These predictions are determined on a cycle by cycle basis. This program is written FORTRAN IV for batch execution and has been implemented on a CDC 6600 computer with a central memory requirement of approximately 101K (octal) of 60 bit words. The POCD program was developed in 1979.

MSC-10013 Naval Ship Research and Development Center, Washington, D. C.

A FINITE ELEMENT ANALYSIS OF LAMINATED ORTHOTROPIC PLATES AND SHALLOW SHELLS

FORTRAN IV 962 source statements
IBM 360
DOD-00076 Price: Program $320.00/Documentation $11.50

Most of the convenient structural analysis and design programs are based on the assumption that the materials involved are isotropic and homogeneous. Many of the structural materials available today exhibit some degree of anisotropy and nonhomogeneity. In order to take advantage of new materials such as fiber reinforced composites, the structural engineer needs a specific analysis tool. This computer program was developed to provide the engineer with a finite element tool for analyzing laminated orthotropic plates and shallow shells under static loads. The program features a laminated shallow shell element, where each lamina may have a different thickness and different material properties. Use of the program is limited to linearly elastic structures. The solution technique used by the program is based on the standard finite element displacement method. A special laminated shallow shell element was developed by extending the standard shell element. This was accomplished by subdividing the shell thickness into separate laminas. The orthotropic stress-strain relationship is explicitly included for each lamina of the shell. The structure to be analyzed is modeled using these rectangular shell elements. The program can handle problems with up to 64 elements and 84 nodes. Each of the shell elements may contain as many as 10 lamina. The program output includes node displacements and stresses in each lamina. This program is written in FORTRAN IV for batch execution and has been implemented on an IBM 360 series computer with a central memory requirement of approximately 102K of 8 bit bytes. This program was developed in 1970.

MSC-10014 California Univ. at Los Angeles.

ACCESS3: APROXIMATION CONCEPTS CODE FOR EFFICIENT STRUCTURAL SYNTHESIS

FORTRAN IV 9,000 source statements
CDC CYBER 70
LAR-12699 Price: Program $1100.00/Documentation $36.50

Approximation concepts and dual method algorithms have been combined in this program to create a new method of minimum weight design for structural systems. The Approximation Concepts Code for Efficient Structural Synthesis (ACCESS3) program was developed to provide the structural system designer with a powerful and efficient tool for the synthesis of minimum weight designs. The ACCESS3 program can be regarded as an advanced research tool in which mathematical programming and optimality criteria approaches are coalesced to provide an efficient and reliable structural weight minimization method. Approximation concepts are used to convert the general structural synthesis problem into a sequence of explicit problems of separable algebraic form. The dual method exploits this separable form to construct a sequence of explicit dual functions. These dual functions are maximized subject to nonnegativity constraints on the dual variables. This approach has proven very efficient because the dimensionality of the dual space, where most of the optimization effort is expended, is relatively low for most structural optimization problems of practical interest. A rather general class of structural optimization problems can be concisely stated as a nonlinear programming (NLP) problem involving the minimization of an objective function subject to a set of inequality constraints. For practical structural design applications, the associated NLP problem is often very complicated due to the large number of design variables, the large set of inequality constraints, and the computational difficulties associated with the constraint functions. The ACCESS3 approach makes such an NLP problem tractable by replacing it with a sequence of relatively small, explicit mathematical programming problems which approximate the original problem while retaining important problem features. This is accomplished through the coordinated use of design variable linking, constraint deletion techniques, and explicit approximations

for retained constraints. Structures with prescribed configurations and given material properties can be optimized so that their structural weight is minimized. This is achieved by modifying the sizing of the finite elements, in particular their cross sectional areas of thicknesses. Types of finite elements available in the ACCESS3 program include a truss element, an isotropic constant strain triangular membrane element, a constant strain triangular element with arbitrary orthotropic material properties, an isotropic shear panel element, and a thermal shear panel element. A thermal load analysis capability is included for problems involving load vectors which are dependent on design variables. In addition to the usual Taylor series expansion with respect to the reciprocals of linked design variables, natural frequency constraints may be represented as first or second order Taylor series expansions with respect to regular linked variables. Four distinct optimizer algorithm options are available in the ACCESS3 program. These are the interior point penalty function method, the second order primal projection method, the second order Newton-type dual method, and the first order gradient projection-type dual method. Input data for ACCESS3 consists of a finite element model which exhibits the topological form, the geometrical configuration, and the structural materials of the structural system to be optimized, along with a set of structural loads and a selection of program options. Output includes a description of the resizing of elements required to achieve minimum weight. The ACCESS3 program is written in FORTRAN IV for batch execution and has been implemented on a CDC CYBER 70 series computer with a central memory requirement of approximately 74K (octal) of 60 bit words. The ACCESS3 program was developed in 1979.

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells and batteries; global sources of energy; fossil fuels; geophysical conversion; hydroelectric power; and wind power.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *85 Urban Technology and Transportation.*

M80-10018* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ESEA: ENERGY SYSTEMS ECONOMIC ANALYSIS PROGRAM
FORTRAN V 530 source statements
UNIVAC 1100
NPO-15097 Price: Program $340.00/Documentation $16.50

When planning an energy system, it is important to have a standard and consistent method of establishing and combining relevant economic parameters in order to support the comparison of different systems. A standard technique is particularly desirable for determining the commercial attractiveness of alternative, as opposed to conventional, energy system designs. The Energy Systems Economic Analysis (ESEA) program was developed to provide a flexible analytical tool which could be used for the rank ordering of alternative energy systems. The basic ESEA approach is to derive an estimate of those costs incured as a result of purchasing, installing, and operating a given energy system, excluding transmission and distribution cost. These costs, suitably aggregated into yearly costs over the lifetime of the system, are divided by the expected yearly energy output to determine the base energy cost. The ESEA analysis may be applied to a variety of energy systems from utility owned fossil fuel or solar electric systems to individual owned residential systems. The ESEA program performs an energy cost analysis of a given energy system based on an established economic model for energy systems. Inputs to the model consist of technical and cost data describing the energy system to be analyzed, escalation rates applicable to various categories of system-resultant cost, and pertinent characteristics of the financial environment. The system description data details the basic costs of the system purchase, installation, and operation. This data also describes the system performance characteristics. The escalation rates determine the conversion of stated costs into current year dollars over the analysis period. The financial environment data influences the direct costs of system ownership. The ESEA system allows for the inclusion of tax preference factors in the form of accelerated depreciation and investment tax credits. In general, the program first determines the discount rate and computes the capital costs, the capital recovery factor, and the fixed charge rate. Next the input costs data is analyzed to compute the present values of cash flows, capital investment, and recurrent costs. All of these system factors are employed to determine an annualized system-resultant cost. Finally, the life-cycle cost, net present value, and base energy cost are computed. The ESEA analysis may be run for several energy systems so that side-by-side comparisons of the results may be performed. The ESEA program is written in FORTRAN IV for batch execution and has been implemented on a UNIVAC 1100 computer with a central memory requirement of approximately 20K of 36 bit bytes. ESEA was developed in 1979.

60 COMPUTER OPERATIONS AND HARDWARE

Includes computer graphics and data processing.

For components see *33 Electronics and Electrical Engineering.*

M80-10016 Alabama Univ. at Huntsville.
DDL: DIGITAL SYSTEMS DESIGN LANGUAGE
FORTRAN IV 6,722 source statements
SEL 32
MFS-25352 Price: Program $680.00/Documentation $17.00

Just as software designers use high level languages to express algorithms in terms of concise language statements, digital hardware designers use hardware description languages to describe the system they are designing. Hardware description languages have proven to be valuable tools in such applications as hardware design, system documentation, and logic design training. The Digital Systems Design Language (DDL) is a hardware description language which provides a convenient medium for inputting design details into a design automation system. A translator program and a simulator program have been developed to allow hardware designers to benefit from the use of the DDL language. In DDL, the structural elements of the system are explicitly declared. At a lower level of description, functional and structural elements correspond directly to the actual physical elements of the system. DDL is highly suitable for describing digital systems at the gate, register transfer, and major combinational block level. DDL is a 'block-oriented' language which the designer can use to describe the functional specifications of a digital system. The blocks of a DDL description usually correspond to the natural divisions of the hardware being described. Thus a DDL description of a computer might have a major block called an 'ALU', which contains a block called 'adder', which consists of interconnected logic blocks called 'full-adders'. The DDL language can be used to describe parallel operations as well as both synchronous and asynchronous behaviors. The DDL translator program (DDLTRN) translates the user supplied DDL description of a system into a set of Boolean equations and register-transfer statements. The output from DDLTRAN is used as input for the DDL simulation program (DDLSIM). DDLSIM enables the system designer to test and verify the design of the digital system. DDLSIM is a table-driven, event-oriented simulator. Time is treated as a discrete quantity and advanced on an event by event basis. Through the use of command statements, the response of the simulated system to a wide variety of input signals may be determined. The DDLTRN and DDLSIM programs are written in FORTRAN IV for batch execution on the SEL-32 computer. Each program requires approximately 64K of 8 bit bytes on the SEL-32. These digital system design aids were developed in 1979.

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

MSC-10017* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INTERP3: A COMPUTER ROUTINE FOR LINEAR INTERPOLATION OF TRIVARIATE FUNCTIONS DEFINED BY NONDISTINCT UNEQUALLY SPACED VARIABLES
FORTRAN IV 238 source statements
CDC 6000
LAR-12853 Price: Program/Documentation $45.00

INTERP3 is a computer program designed to linearly interpolate a variable that is a function of three independent parameters. The variables within the parameter arrays do not have to be distinct, or equally spaced, and the variable may be in increasing or decreasing order. Extrapolation from values in the data table is not permitted. Input to the program is a set of values for the function of interest at points defined by the three independent parameters. A sample driver routine is included. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6600 computer with a central memory requirement of approximately 112K (octal) of 60 bit words. INTERP3 was developed in 1979.

MSC-10018* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
AN EXACT TRANSFORMATION FROM GEOCENTRIC TO GEODETIC COORDINATES FOR NONZERO ALTITUDES
FORTRAN IV 372 source statements
CDC 6000
FRC-11048 Price: Program $50.00/Documentation $3.50

In space position measurement systems, it is often necessary to perform a transformation from geocentric to geodetic coordinates. For these systems it is important to have an exact closed-form solution for the transformation. In such applications as determining missile positions, it is particularly important to have an exact solution which is free from embedded singularities. This computer program was developed to provide the user with an exact, singularity free, solution to the transformation problem. The solution technique is based on an exact mathematical formulation of the transformation problem. The computational accuracy of the program is limited only by the accuracy of the computer used. This transformation solution provides a primary standard which can be used to evaluate approximate solutions which are sometimes used in noncritical applications. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6600 computer with a central memory requirement of approximately 32K (octal) of 60 bit words. This exact transformation program was developed in 1976.

MSC-10019* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
AN ALGORITHM AND COMPUTER PROGRAM TO LOCATE REAL ZEROS OF REAL POLYNOMIALS
FORTRAN IV 465 source statements
CDC 6000
FRC-11049 Price: Program $50.00/Documentation $4.50

Finding the real zeros of polynomials is a classical problem in almost every technical discipline. Most of the current methods for finding the zeros of real polynomials, including the Laguerre, Newton-Raphson, and Jenkins-Traub methods, determine both the real and the complex zeros of the polynomial. These methods tend to be inefficient when only real zeros are desired and they can sometimes mistake real zeros for complex zeros with a very small imaginary part. This computer program was developed to incorporate an algorithm which efficiently determines only the real zeros of real polynomials. The algorithm is based on a modification of the secant method. Evaluations of the algorithm have shown this method to have a high probability of convergence and a high inherent rate of convergence. The procedure exhibits good stability in problems involving clustered zeros and efficiently determines only the real zeros of polynomials having both real and imaginary zeros. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6600 with a central memory requirement of approximately 31K (octal) of 60 bit words. This program was developed in 1975.

93 SPACE RADIATION

Includes cosmic radiation and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

MSC-10020* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SOFIP: SHORT ORBITAL FLUX INTEGRATION PROGRAM
FORTRAN IV 800 source statements
IBM 360
GSC-12554 Price: Program $140.00/Documentation $7.50

The Short Orbital Flux Integration Program (SOFIP) was developed to provide a fast and accurate evaluation of the space radiation environment expected to be encountered by geocentric satellites. SOFIP uses Vette's standardized models of the terrestrial trapped particle environment in performing the evaluation. For a given trajectory, the basic analysis involves the calculation of the composite integral orbit spectrum of either protons or electrons. Additional calculations which may be performed include exposure index, peaks per orbit, percent time in electron trapping zones, differential spectrum, and solor proton fluences. The results of the SOFIP calculations should provide the analyst with a detailed picture of the radiation environment in which the vehicle will operate. This program is written in FORTRAN IV for batch execution and has been implemented on an IBM 360 computer with a central memory requirement of approximately 60K of 8 bit bytes. The SOFIP program was developed in 1979.

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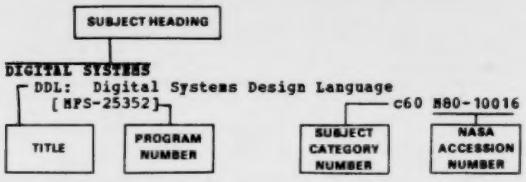

The subject heading is a key to the subject content of the document. The titles, with title extensions if present, are arranged under each subject heading in ascending accession number order. The program number is the number assigned in the COSMIC inventory to identify the coded source. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category.

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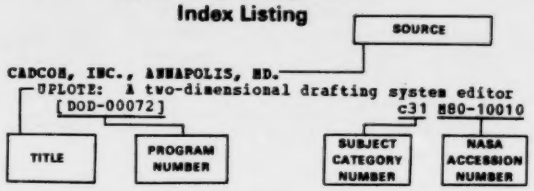
Typical Originating Source Index Listing



Listings in this index are arranged alphabetically by originating source. The title of the document provides the user with a brief description of the subject matter. The program number is the number assigned in the COSMIC inventory to identify the coded source. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category. The titles are arranged under each corporate source in ascending accession number order.

A

ALABAMA UNIV. AT HUNTSVILLE.
DDL: Digital Systems Design Language
[MFS-25352] c60 M80-10016

ARMY AVIATION RESEARCH AND DEVELOPMENT COMMAND, HAMPTON, VA.
POCD: Prediction of Crack and Debond growth in a cracked metal sheet reinforced with composite
[LAR-12696] c39 M80-10012

C

CADCON, INC., ANNAPOLIS, MD.
UPLOTE: A two-dimensional drafting system editor
[DOD-00072] c31 M80-10010

CALIFORNIA UNIV. AT LOS ANGELES.
ACCESS3: Aproximation concepts code for efficient structural synthesis
[LAR-12699] c39 M80-10014

CONCENTRATION HEAT AND MOMENTUM, LTD., LONDON (ENGLAND).
Prediction of hydrodynamics and chemistry of confined turbulent methane-air flames in a two-concentric-tube combustor
[LEW-13388] c25 M80-10006

J

JET PROPULSION LAB., CALIFORNIA INST. OF TECH., PASADENA.
ESEA: Energy Systems Economic Analysis Program
[NPO-15097] c44 M80-10015

N

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.
Optimal aircraft trajectories for specified ranges
[ARC-11282] c05 M80-10004

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. HUGH L. DRYDEN FLIGHT RESEARCH CENTER, EDWARDS, CALIF.
An exact transformation from geocentric to geodetic coordinates for nonzero altitudes
[FRC-11048] c64 M80-10018
An algorithm and computer program to locate real zeros of real polynomials
[FRC-11049] c64 M80-10019

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.
SOFIP: Short Orbital Flux Integration Program
[GSC-12554] c93 M80-10020

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LANGLEY RESEARCH CENTER, LANGLEY STATION, VA.
RAXBOD: A FORTRAN program for inviscid transonic flow over axisymmetric bodies
[LAR-12499] c02 M80-10002
DONBOL: A computer program for predicting axisymmetric nozzle afterbody pressure distributions and drag at subsonic speeds
[LAR-12619] c02 M80-10003
DBASE1: Exact solutions for diffusion in single phase binary alloy systems with planar, cylindrical, or spherical interfaces
[LAR-12665] c26 M80-10007
INTERP3: A computer routine for linear interpolation of trivariate functions defined by nondistinct unequally spaced variables
[LAR-12653] c64 M80-10017

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO.
Computer programs for calculating two-dimensional potential flow in and about propulsion system inlets
[LEW-13278] c34 M80-10011

NAVAL SHIP ENGINEERING CENTER, WASHINGTON, D. C.
HULGEN: Ship hull generator
[DOD-00071] c31 M80-10009

NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER, BETHESDA, MD.
SSDP: Structural Synthesis Design Program
[DOD-00067] c31 M80-10008

NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER, WASHINGTON, D. C.
A finite element analysis of laminated orthotropic plates and shallow shells
[DOD-00076] c39 M80-10013

NORTHROP SERVICES, INC., HUNTSVILLE, ALA.
IUS spin stage six degree of freedom simulation
[MFS-25206] c18 M80-10005

R

ROCKWELL INTERNATIONAL CORP., LOS ANGELES, CALIF.
APAS: Aerodynamic Preliminary Analysis System
[LAR-12404] c02 M80-10001

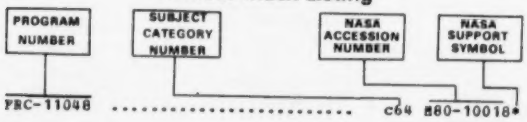
V

VIRGINIA POLYTECHNIC INST., BLACKSBURG.
DBASE1: Exact solucions for diffusion in single phase binary alloy systems with planar, cylindrical, or spherical interfaces
[LAR-12665] c26 M80-10007

SOURCE

COMPUTER PROGRAM ABSTRACTS VOLUME 12 NUMBER 1

Typical Program/Accession Number Index Listing



Listings in this index are arranged alphanumerically by program number. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category. An asterisk (*) indicates NASA support.

ARC-11282 ..... c05 N80-10004*

DOD-00067 ..... c31 N80-10008
DOD-00071 ..... c31 N80-10009
DOD-00072 ..... c31 N80-10010
DOD-00076 ..... c39 N80-10013

FRC-11048 ..... c64 N80-10018*
FRC-11049 ..... c64 N80-10019*

GSC-12554 ..... c93 N80-10020*

LAR-12404 ..... c02 N80-10001
LAR-12499 ..... c02 N80-10002*
LAR-12619 ..... c02 N80-10003*
LAR-12653 ..... c64 N80-10017*
LAR-12665 ..... c26 N80-10007*
LAR-12696 ..... c39 N80-10012
LAR-12699 ..... c39 N80-10014

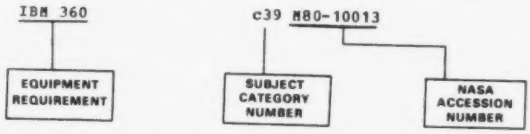
LEW-13278 ..... c34 N80-10011*
LEW-13388 ..... c25 N80-10006

MFS-25206 ..... c18 N80-10005
MFS-25352 ..... c60 N80-10016

NPO-15097 ..... c44 N80-10015*

EQUIPMENT REQUIREMENTS INDEX

Typical Equipment Requirements Index Listing



Equipment requirements are arranged in alphanumeric sequence. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category.

CDC CYBER 70
- c02 N80-10001
- c39 N80-10012
- c39 N80-10014

CDC 6000
- c02 N80-10002
- c02 N80-10003
- c05 N80-10004
- c26 N80-10007
- c31 N80-10008
- c31 N80-10009
- c31 N80-10010
- c64 N80-10017
- c64 N80-10018
- c64 N80-10019

IBM 360
- c39 N80-10013
- c93 N80-10020

SEL 32
- c60 N80-10016

UNIVAC 1100
- c18 N80-10005
- c25 N80-10006
- c34 N80-10011
- c44 N80-10015

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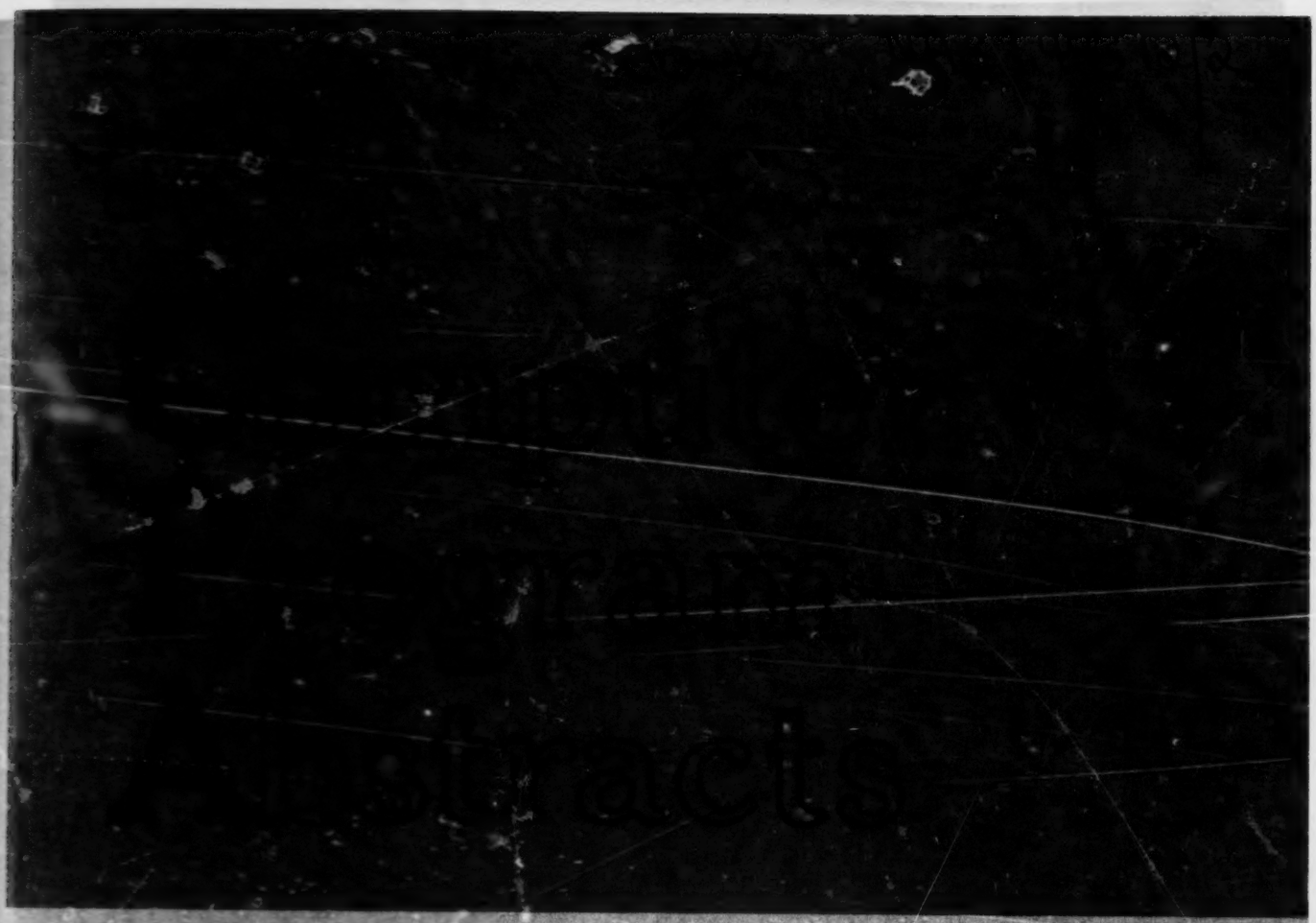

JULY 15, 1980

VOLUME 12 • NUMBER 2

M80-10021—M80-10033

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Computer Program Abstracts is an indexed journal containing abstracts of documented computer programs developed by the National Aeronautics and Space Administration, NASA contractors, and other Federal Agencies, which are offered for sale through the NASA sponsored Computer Software Management and Information Center (COSMIC) located at the University of Georgia.

Computer Program Abstracts is published quarterly by the National Aeronautics and Space Administration and is organized into five sections. The first section contains program citations and abstracts arranged in ten major divisions divided into seventy-four specific subject categories and one general category/division. Following are four sections of indexes: subject, originating source, program number/accession number, and equipment requirements.

The Subject Index is an alphabetical listing of the main subject headings by which the computer programs have been identified.

The Originating Source Index is an alphabetical listing of the names of organizations responsible for the computer programs contained in the journal.

The Program Number/Accession Number Index provides a cross-index from the program number assigned in the COSMIC inventory to identify coded source and sequence to the corresponding accession number assigned sequentially to abstracts in *Computer Program Abstracts*.

The Equipment Requirements Index comprises an alphanumeric listing of the kinds of equipment required for the use of the computer programs included in the journal.

Computer programs and related documentation listed in *Computer Program Abstracts* can be ordered at prices indicated in the Abstract Section from COSMIC. Prices are subject to change without notice. Prices include normal shipping charges; special shipping can be arranged at the customer's expense. All orders should specify billing procedures and specific item(s) desired; i.e., documentation only, or both documentation and program.

In most cases, programs described in current issues of this publication are available to domestic customers only. However, many programs announced in previous issues of the journal are available to organizations outside the United States. COSMIC will be pleased to provide information concerning international availability and pricing of software upon request.

Any questions concerning new software announced in *Computer Program Abstracts* or COSMIC's existing inventory of 1500 programs should be directed to the COSMIC Customer Service Staff at the following address:

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Athens, GA 30602

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The Computer Software Management and Information Center (COSMIC) is operated for NASA by the University of Georgia for the purpose of making computer programs developed in the space program available to the public. Many programs from the Department of Defense and selected software from other government agencies are also offered. At present, over 1500 programs in almost every technical or managerial discipline are available.

Before offering a program for sale, COSMIC ascertains that it will compile and that the documentation describing it is adequate. Then a brief description is written for inclusion in *Computer Program Abstracts*, which is the complete catalog of software that is available. Especially useful programs are also described in *NASA Tech Briefs*, a free quarterly publication containing about 150 articles on NASA innovations of all types thought to have commercial application. To get on the mailing list for Tech Briefs, write NASA, Code ETU-6, Washington, DC 20546.

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112 Barrow Hall
The University of Georgia
Athens, Georgia 30602
Telephone: (404) 542-3265

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TABLE OF CONTENTS

AERONAUTICS

Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics*.

01 AERONAUTICS (GENERAL) N.A.

02 AERODYNAMICS N.A.

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer*.

03 AIR TRANSPORTATION AND SAFETY N.A.

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation*.

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION N.A.

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Spacecraft Communications, Command and Tracking* and *32 Communications*.

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE N.A.

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.

06 AIRCRAFT INSTRUMENTATION N.A.

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography*.

07 AIRCRAFT PROPULSION AND POWER 9

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion*.

08 AIRCRAFT STABILITY AND CONTROL N.A.

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

09 RESEARCH AND SUPPORT FACILITIES (AIR) N.A.

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

For related information see also *14 Ground Support Systems and Facilities (Space)*.

ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

For related information see also *Aeronautics*.

12 ASTRONAUTICS (GENERAL) N.A.

For extraterrestrial exploration see *91 Lunar and Planetary Exploration*.

13 ASTRODYNAMICS N.A.

Includes powered and free-flight trajectories; and orbit and launching dynamics.

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE) N.A.

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air)*.

15 LAUNCH VEHICLES AND SPACE VEHICLES N.A.

Includes boosters; manned orbital laboratories; reusable vehicles; and space stations.

16 SPACE TRANSPORTATION N.A.

Includes passenger and cargo space transportation, e.g., shuttle operations; and rescue techniques.

For related information see also *03 Air Transportation and Safety* and *85 Urban Technology and Transportation*.

17 SPACECRAFT COMMUNICATIONS, COMMAND AND TRACKING N.A.

Includes telemetry; space communications networks; astronavigation; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications*.

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE N.A.

Includes spacecraft thermal and environmental control; and attitude control.

For life support systems see *54 Man/System Technology and Life Support*. For related information see also *05 Aircraft Design, Testing and Performance* and *39 Structural Mechanics*.

19 SPACECRAFT INSTRUMENTATION **N.A.**

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography*.

20 SPACECRAFT PROPULSION AND POWER **10**

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion*.

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

23 CHEMISTRY AND MATERIALS (GENERAL) **N.A.**

Includes biochemistry and organic chemistry.

24 COMPOSITE MATERIALS **N.A.**

Includes laminates.

25 INORGANIC AND PHYSICAL CHEMISTRY **N.A.**

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics*.

26 METALLIC MATERIALS **N.A.**

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

27 NONMETALLIC MATERIALS **N.A.**

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

28 PROPELLANTS AND FUELS **N.A.**

Includes rocket propellants, igniters, and oxidizers; storage and handling; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion*.

ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

For related information see also *Physics*.

31 ENGINEERING (GENERAL) **N.A.**

Includes vacuum technology; control engineering; display engineering; and cryogenics.

32 COMMUNICATIONS **10**

Includes land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Spacecraft Communications, Command and Tracking*.

33 ELECTRONICS AND ELECTRICAL ENGINEERING **N.A.**

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics*.

34 FLUID MECHANICS AND HEAT TRANSFER **10**

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics*.

35 INSTRUMENTATION AND PHOTOGRAPHY **N.A.**

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources*. For related information see also *06 Aircraft Instrumentation* and *19 Spacecraft Instrumentation*.

36 LASERS AND MASERS **N.A.**

Includes parametric amplifiers.

37 MECHANICAL ENGINEERING **N.A.**

Includes auxiliary systems (non-power); machine elements and processes; and mechanical equipment.

38 QUALITY ASSURANCE AND RELIABILITY **N.A.**

Includes product sampling procedures and techniques; and quality control.

39 STRUCTURAL MECHANICS **11**

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance*.

GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

For related information see also *Space Sciences*.

42 GEOSCIENCES (GENERAL) **N.A.**

43 EARTH RESOURCES 12

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography*.

44 ENERGY PRODUCTION AND CONVERSION N.A.

Includes specific energy conversion systems, e.g., fuel cells and batteries; global sources of energy; fossil fuels; geophysical conversion; hydroelectric power; and wind power.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power, 28 Propellants and Fuels*, and *85 Urban Technology and Transportation*.

45 ENVIRONMENT POLLUTION N.A.

Includes air, noise, thermal and water pollution; environment monitoring; and contamination control.

46 GEOPHYSICS N.A.

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation*.

47 METEOROLOGY AND CLIMATOLOGY N.A.

Includes weather forecasting and modification.

48 OCEANOGRAPHY N.A.

Includes biological, dynamic and physical oceanography; and marine resources.

LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

51 LIFE SCIENCES (GENERAL) N.A.

Includes genetics.

52 AEROSPACE MEDICINE N.A.

Includes physiological factors; biological effects of radiation; and weightlessness.

53 BEHAVIORAL SCIENCES N.A.

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT N.A.

Includes human engineering; biotechnology; and space suits and protective clothing.

55 PLANETARY BIOLOGY N.A.

Includes exobiology; and extraterrestrial life.

MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL) N.A.

60 COMPUTER OPERATIONS AND HARDWARE N.A.

Includes computer graphics and data processing.

For components see *33 Electronics and Electrical Engineering*.

61 COMPUTER PROGRAMMING AND SOFTWARE 12

Includes computer programs, routines, and algorithms.

62 COMPUTER SYSTEMS N.A.

Includes computer networks.

63 CYBERNETICS N.A.

Includes feedback and control theory.

For related information see also *54 Man/System Technology and Life Support*.

64 NUMERICAL ANALYSIS 12

Includes iteration, difference equations, and numerical approximation.

65 STATISTICS AND PROBABILITY 13

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

66 SYSTEMS ANALYSIS N.A.

Includes mathematical modeling; network analysis; and operations research.

67 THEORETICAL MATHEMATICS N.A.

Includes topology and number theory.

PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

For related information see also *Engineering*.

70 PHYSICS (GENERAL) N.A.

For geophysics see *46 Geophysics*. For astrophysics see *90 Astrophysics*. For solar physics see *92 Solar Physics*.

71 ACOUSTICS N.A.
Includes sound generation, transmission, and attenuation.
For noise pollution see *45 Environment Pollution*.

72 ATOMIC AND MOLECULAR PHYSICS 13
Includes atomic structure and molecular spectra.

73 NUCLEAR AND HIGH-ENERGY PHYSICS N.A.
Includes elementary and nuclear particles; and reactor theory.
For space radiation see *93 Space Radiation*.

74 OPTICS N.A.
Includes light phenomena.

75 PLASMA PHYSICS N.A.
Includes magnetohydrodynamics and plasma fusion.
For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

76 SOLID-STATE PHYSICS N.A.
Includes superconductivity.
For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers*.

77 THERMODYNAMICS AND STATISTICAL PHYSICS N.A.
Includes quantum mechanics; and Bose and Fermi statistics.
For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer*.

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

80 SOCIAL SCIENCES (GENERAL) N.A.
Includes educational matters.

81 ADMINISTRATION AND MANAGEMENT N.A.
Includes management planning and research.

82 DOCUMENTATION AND INFORMATION SCIENCE N.A.
Includes information storage and retrieval technology; micrography; and library science.
For computer documentation see *61 Computer Programming and Software*.

83 ECONOMICS AND COST ANALYSIS N.A.
Includes cost effectiveness studies.

84 LAW AND POLITICAL SCIENCE N.A.
Includes space law; international law; international cooperation; and patent policy.

85 URBAN TECHNOLOGY AND TRANSPORTATION N.A.
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.
For related information see *03 Air Transportation and Safety*, *16 Space Transportation*, and *44 Energy Production and Conversion*.

SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.
For related information see also *Geosciences*.

88 SPACE SCIENCES (GENERAL) N.A.

89 ASTRONOMY N.A.
Includes radio and gamma-ray astronomy; celestial mechanics; and astrometry.

90 ASTROPHYSICS N.A.
Includes cosmology; and interstellar and interplanetary gases and dust.

91 LUNAR AND PLANETARY EXPLORATION N.A.
Includes planetology; and manned and unmanned flights.
For spacecraft design see *18 Spacecraft Design, Testing and Performance*. For space stations see *15 Launch Vehicles and Space Vehicles*.

92 SOLAR PHYSICS N.A.
Includes solar activity, solar flares, solar radiation and sunspots.

93 SPACE RADIATION N.A.
Includes cosmic radiation; and inner and outer earth's radiation belts.
For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

GENERAL

99 GENERAL N.A.

Note: N.A. means that no abstracts were assigned to this category for this issue.

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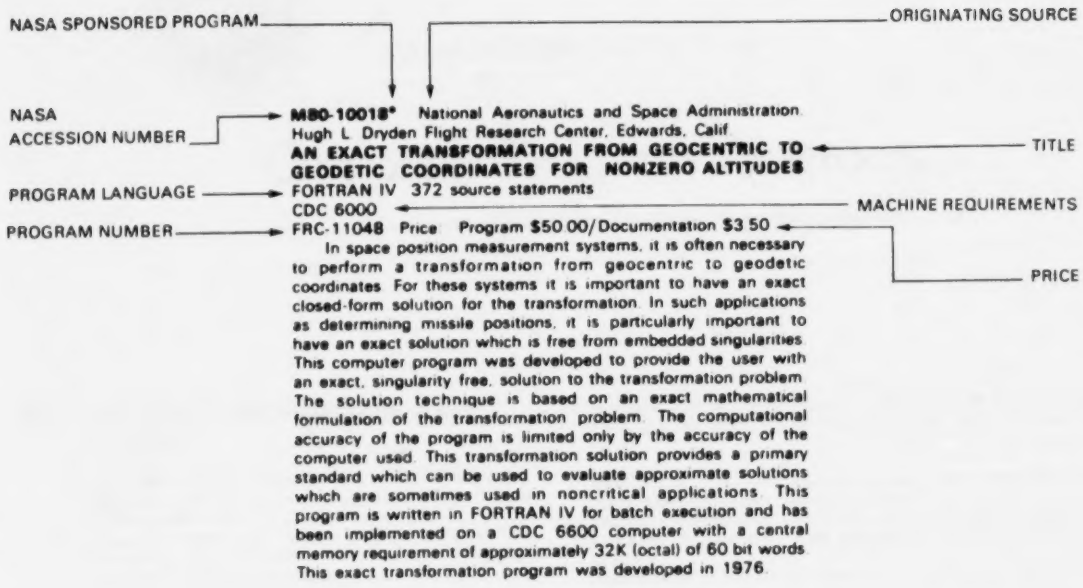
TYPICAL CITATION AND ABSTRACT


NASA SPONSORED PROGRAM
ORIGINATING SOURCE
NASA ACCESSION NUMBER
N80-10018* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
AN EXACT TRANSFORMATION FROM GEOCENTRIC TO GEODETIC COORDINATES FOR NONZERO ALTITUDES
TITLE
PROGRAM LANGUAGE
FORTRAN IV. 372 source statements
CDC 6000
MACHINE REQUIREMENTS
PROGRAM NUMBER
FRC-11048 Price: Program $50.00/Documentation $3.50
PRICE
In space position measurement systems, it is often necessary to perform a transformation from geocentric to geodetic coordinates. For these systems it is important to have an exact closed-form solution for the transformation. In such applications as determining missile positions, it is particularly important to have an exact solution which is free from embedded singularities. This computer program was developed to provide the user with an exact, singularity free, solution to the transformation problem. The solution technique is based on an exact mathematical formulation of the transformation problem. The computational accuracy of the program is limited only by the accuracy of the computer used. This transformation solution provides a primary standard which can be used to evaluate approximate solutions which are sometimes used in noncritical applications. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6600 computer with a central memory requirement of approximately 32K (octal) of 60 bit words. This exact transformation program was developed in 1976.

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Computer Program Abstracts

A Quarterly Publication of the National Aeronautics and Space Administration

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

M80-10021* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DYGABCD: A PROGRAM FOR CALCULATING LINEAR A, B, C, AND D MATRICES FROM A NONLINEAR DYNAMIC ENGINE SIMULATION

FORTRAN IV 5,015 source statements

IBM 360

LEW-13250 Price: Program $920.00/Documentation $24.50

Most of the analytical design approaches used by control engineers require linear descriptions of the steady state and transient characteristics of the engine being controlled. To accomplish accurate modeling, nonlinear steady state and transient physical relationships must be included. The DYGABCD program was developed to provide the control engineer with the ability to calculate linear approximations from nonlinear dynamic engine simulations. Once these linear approximations have been obtained, they can be used to accurately simulate the performance characteristics of turbofan or turbojet engines using standard linear approaches. The DYGABCD program can also be used to calculate performance characteristics from the linear approximations generated. For a system as complex as an aircraft engine, the linear system description generally consists of a number of interdependent linear algebraic and differential equations. The system description is usually expressed in matrix notation. A widely accepted linear dynamic system representation involves a system matrix A, a control matrix B, an output matrix C, and a feed-forward matrix D. The DYGABCD program simulates the nonlinear dynamics of the engine for a given power setting and flight condition and calculates the approximate linear A, B, C, and D matrices. This linear approximation to the nonlinear system is valid only in a small region about the specified operating point; therefore DYGABCD generates a family of linear state matrices about numerous power settings and flight conditions. These state matrices may be used by any engine simulation program, including DYGABCD, to simulate engine performance over a wide range of operating conditions. Input to DYGABCD consists of a physical description of the turbofan or turbojet engine system and the range of operating conditions over which the approximations are to be calculated. Output consists of the family of state matrices calculated by the program. If performance calculations are requested, the output includes the calculated values for any of the engine performance variables specified by the user. This program is written in FORTRAN IV for batch execution and has been implemented on an IBM 360 series computer with a central memory requirement of approximately 314K of 8 bit bytes. The DYGABCD program was developed in 1978.

M80-10022* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TACT1: TRANSIENT THERMAL ANALYSIS OF A COOLED TURBINE BLADE OR VANE EQUIPPED WITH A COOLANT INSERT

FORTRAN IV 6,007 source statements

IBM 360

LEW-13293 Price: Program $900.00/Documentation $17.50

As turbine engine core operating conditions become more severe, designers must develop more effective means of cooling blades and vanes. In order to design reliable, cooled turbine blades, advanced transient thermal calculation techniques are required. The TACT1 computer program was developed to perform transient and steady state, heat transfer and coolant flow analyses for cooled blades, given the outside hot gas boundary condition, the coolant inlet conditions, the geometry of the blade shell, and the cooling configuration. The TACT1 computer program can analyze turbine blades, or vanes, equipped with a central coolant plenum insert from which coolant air impinges on the inner surface of the blade shell. Coolant side, heat transfer coefficients are calculated with the heat transfer mode at each station being user specified as either impingement with crossflow, forced convection channel flow, or forced convection over pin fins. A limited capability to handle film cooling is also available in the program. The TACT1 program solves for the blade temperature distribution using a transient energy equation for each node. The nodal energy balances are linearized, one dimensional, heat conduction equations which are applied at the wall-outer-surface node, at the junction of the cladding and the metal node, and at the wall-inner-surface node. At the mid-metal node a linear, three dimensional, heat conduction equation is used. Similarly, the coolant pressure distribution is determined by solving the set of transfer momentum equations for the one dimensional flow between adjacent fluid nodes. In the coolant channel, energy and momentum equations for one dimensional compressible flow, including friction and heat transfer, are used for the elemental channel length between two coolant nodes. The TACT1 program first obtains a steady state solution using iterative calculations to obtain convergence of stable temperatures, pressures, coolant flow split, and overall coolant mass balance. Transient calculations are based on the steady state solutions obtained. Input to the TACT1 program includes a geometrical description of the blade and insert, the nodal spacing to be used, and the boundary conditions describing the outside hot gas and the coolant inlet conditions. The program output includes the value of nodal temperatures and pressures at each interation. The final solution output includes the temperature at each coolant node, and the coolant flow rates and Reynolds numbers. This program is written in FORTRAN IV for batch execution and has been implemented on an IBM 360 computer with a central memory requirement of approximately 480K of 8 bit bytes. The TACT1 program was developed in 1978.

20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components e.g., rocket engines; and spacecraft auxiliary power sources.

For related information see also *07 Aircraft Propulsion, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

M80-10023 McDonnell-Douglas Corp., St. Louis, Mo.
PIM900: PLUME IMPINGEMENT MODEL PRIMARY RCS VERSION
FORTRAN IV (90 percent), ASSEMBLER (10 percent) 1,890 source statements
UNIVAC 1100
MSC-18484 Price: Program $460.00/Documentation $18.00

The PIM900 program was developed to compute the plume impingement forces and moments on space shuttle orbiter payloads during such on-orbit operations as deployment, stationkeeping, and retrieval. The PIM900 is a medium fidelity program which provides for fast execution, moderate computer storage demands, and reasonable ease of use. The program first computes the normal and tangential pressure coefficients in the continuum, transitional, and free molecular impingement regimes. In the continuum regime, the normal pressure coefficient is computed using a modified Newtonian formulation and the tangential coefficients are set to zero. In the free molecular regime, normal and tangential coefficients are computed using a thermal accommodation formulation, with simplifying approximations used in the appropriate range of impingement angles. In the transitional regime, a weighted sum of the continuum and free molecular calculations is formed using a piecewise linear function of the log of the Knudsen number. These pressure coefficients are used to calculate the instantaneous forces and moments on any impinged object. The PIM900 program can be used as a stand alone program with the user supplying information on the plume characteristics and the impinged object geometry. Output consists of flow field data and the resultant instantaneous forces and moments. A plume model is currently included for the shuttle orbiter primary reaction control system motors. The PIM900 could also be integrated into a complete on-orbit simulation program. The PIM900 program is written in FORTRAN IV and ASSEMBLER for batch execution and has been implemented on a UNIVAC 1100 series computer with a central memory requirement of approximately 10K of 36 bit words. The PIM900 program was developed in 1978.

32 COMMUNICATIONS

Includes land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Spacecraft Communications, Command and Tracking.*

M80-10024 Old Dominion Univ., Norfolk, Va.
THEORETICAL RESPONSE OF CONDENSER MICROPHONES
BASIC 400 source statements
HP 9830A
LAR-12684 Price: Program/Documentation $50.00

This computer program was developed to compute the theoretical response of a conventional condenser microphone in terms of its geometrical properties and the properties of the ambient gas. The program analyzes microphones having a circular membrane, clamped around the periphery, and accounts for membrane damping, as influenced by ambient gas viscosity, backplate configuration, and back chamber volume. The backplate is assumed to have a peripheral slot and may contain up to three rings of radially symmetric holes of small dimensions. The ambient gas may have any pressure and composition as long as its density, viscosity, isothermal sound velocity, and specific heat ratio are known. The incident sound pressure is assumed uniform over the membrane area and harmonically varying in time. The response of the microphone is computed based on a modified Petritskaya method. This modified approach yields a closed form solution which readily leads to obtaining solutions by computerized techniques. The user supplies only data describing the geometry of the microphone and the properties of the ambient gas. The program computes the frequency response in terms of the magnitude and phase angle of the average membrane displacement, compliance of the air layer, equivalent lumped resistance, and the quality factor. These frequency dependent quantities are computed for 60 frequencies: the first 40 frequencies are at 1/3 octave intervals between 10 Hz and 80 kHz, and the last 20 frequencies are in close increments centered about the first membrane vacuum resonant frequency. Several frequency independent quantities are also computed including membrane compliance and the first three membrane vacuum resonant frequencies. This program is written in HP BASIC for execution on the HP 9830A computer with a memory requirement of 8K. This program was developed in 1979.

34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

M80-10025 Rockwell International Corp., Downey, Calif.
TPS MULTIDIMENSIONAL HEAT CONDUCTION PROGRAM
FORTRAN IV 8,000 source statements
CDC CYBER 70
MSC-18616 Price: Program $900.00/Documentation $20.00

The Thermal Protection System (TPS) for the space shuttle consists of an outer layer of rigid surface insulation tiles. It is important that an accurate understanding of the thermal behavior of this system be obtained prior to usage. This computer program was developed to compute the transient temperature history and the steady state temperatures of complex body geometries in three dimensions. Emphasis has been placed on the type of problems associated with the TPS but the program could be used in the thermal analysis of most three dimensional systems. The thermal model is subdivided into sections, or nodes, to a level of approximation which yields the desired level of accuracy. Input to the program consists of a geometrical description of the physical system, the material properties, and selected boundary conditions. The boundary conditions are used to account for heat flux, reradiation, radiation interchange, convection, fixed temperatures, and phase changes. The program will accommodate a thermal model with as many as 500 nodes, 4000 conductors, 3600 radiation interchange conductors, and 75 of each type of boundary condition. The program solves the differential equations describing the transient and steady state behavior of the model using finite difference techniques. For the transient analysis, the user may select either a forward difference method, a midpoint difference (Crank-Nicolson) method, a backward difference method, or an alternating direction method to numerically solve the governing equations. For the steady state analysis, a modified backward difference method is available. Program output is in the form of temperature versus time histories for each section of the thermal model. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC CYBER 170 series machine with a segmented memory requirement of approximately 230K (octal) of 60 bit words. This program was developed in 1979.

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance*.

M80-10026 Rockwell International Corp., Downey, Calif.
FLAGRO4: ADVANCED CRACK PROPAGATION PREDICTIVE ANALYSIS PROGRAM
FORTRAN IV 5,688 source statements
CDC 6000
MSC-18718 Price: Program $810.00/Documentation $12.50

Structural flaws and cracks may grow under fatigue inducing loads and, upon reaching a critical size, cause structural failure to occur. The growth of these flaws and cracks may occur at load levels well below the ultimate load bearing capability of the structure. The Advanced Crack Propagation Predictive Analysis Program, FLAGRO4, was developed as an aid in predicting the growth of pre-existing flaws and cracks in structural components FLAGRO4 provides the fracture mechanics analysts with a computerized method of evaluating the safe crack growth life capabilities of structural components. The FLAGRO4 could also be used to evaluate the damage tolerance aspects of a given structural design. The propagation of an existing crack is governed by the stress field in the vicinity of the crack tip. The stress intensity factor is defined in terms of the relationship between the stress field magnitude and the crack size. The propagation of the crack becomes catastrophic when the local stress intensity factor reaches the fracture toughness of the material. The FLAGRO4 predicts crack growth using a two dimensional model which independently predicts flaw growth in two directions based on the calculation of stress intensity factors. The analyst may specify that the growth rate be controlled by Collipriest's equation, Forman's equation, Paries' equation, or by tabulated, user supplied data. FLAGRO4 can model part-through, through, and corner cracks located on panels, on panel edges, at open holes, at pin loaded holes, at pin loaded lugs, and on tub or bar surfaces. The modeling of the crack growth may be continued until propagation becomes catastrophic. The FLAGRO4 can accommodate part through to through crack transitions, stress gradients across the width and thickness, cold worked hole residual stresses, material property variations due to environmental changes, and Willenberg retardation. Input to FLAGRO4 consists of initial crack definition (which can be defined automatically), rate solution type, flaw type and geometry, material properties (if they are not in the built-in material table), load spectrum data, load-stress functions, and design limit stress levels. The FLAGRO4 output includes an echo of the input with any error or warning messages and a life history profile of the crack propagation. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6000 series machine with a central memory requirement of approximately 150K (octal) of 60 bit words. The FLAGRO4 program was developed in 1979.

M80-10027 Rockwell International Corp., Downey, Calif.
FLAGRO4: ADVANCED CRACK PROPAGATION PREDICTIVE ANALYSIS PROGRAM
FORTRAN IV 5,685 source statements
IBM 360
MSC-18721 Price: Program $810.00/Documentation $12.50

Structural flaws and cracks may grow under fatigue inducing loads and, upon reaching a critical size, cause structural failure to occur. The growth of these flaws and cracks may occur at load levels well below the ultimate load bearing capability of the structure. The Advanced Crack Propagation Predictive Analysis Program, FLAGRO4, was developed as an aid in predicting the growth of pre-existing flaws and cracks in structural components. The FLAGRO4 provides the fracture mechanics analysts with a computerized method of evaluating the safe crack growth life capabilities of structural components. The FLAGRO4 could also be used to evaluate the damage tolerance aspects of a given structural design. The propagation of an existing crack is governed by the stress field in the vicinity of the crack tip. The stress intensity factor is defined in terms of the relationship between the stress field magnitude and the crack size. The propagation of the crack becomes catastrophic when the local stress intensity factor reaches the fracture toughness of the material. The FLAGRO4 predicts crack growth using a two dimensional model which independently predicts flaw growth in two directions based on the calculation of stress intensity factors. The analyst may specify that the growth rate be controlled by Collipriest's equation, Forman's equation, Paries' equation, or by tabulated, user supplied data. The FLAGRO4 can model part-through, through, and corner cracks located on panels, on panel edges, at open holes, at pin loaded holes, at pin loaded lugs, and on tub or bar surfaces. The modeling of the crack growth may be continued until propagation becomes catastrophic. FLAGRO4 can accommodate part through crack transitions, stress gradients across the width and thickness, cold worked hole residual stresses, material property variations due to environmental changes, and Willenberg retardation. Input to FLAGRO4 consists of initial crack definition (which can be defined automatically), rate solution type, flaw type and geometry, material properties (if they are not in the built-in material table), load spectrum data, load-stress functions, and design limit stress levels. The FLAGRO4 output includes an echo of the input with any error or warning messages and a life history profile of the crack propagation. This program is written in FORTRAN IV for batch execution and has been implemented on an IBM 360 series machine with a central memory requirement of approximately 260K (octal) of 8 bit bytes. The FLAGRO4 program was developed in 1979.

M80-10028 Illinois Inst. of Tech., Chicago.
PARS: PROGRAM FOR ANALYSIS AND RESIZING OF STRUCTURES
FORTRAN IV 10,500 source statements
CDC CYBER 70
LAR-12704 Price: Program $1250.00/Documentation $21.00

The Program for Analysis and Resizing of Structures (PARS) was developed as an efficient optimization program for resizing structures subject to stress, displacement, and flutter constraints. The PARS program based on the SPAR finite element system (COSMIC Program LAR-12542) and is composed of a group of individual processors. These processors are used in a logical sequence to perform desired analysis or synthesis tasks. The processors are able to communicate directly and automatically with a 'data complex' which contains the information generated by each processor during a computer run. The PARS program can be used to resize structural systems that can be idealized using truss, beam, shear panels, and triangular or quadrilateral membrane or plate elements. All elements, excepting the beam elements, may be resized. The PARS program provides an efficient code for sizing larger or small scale finite element models in the presence of strength, thermal, and aeroelastic constraints with minimum and maximum bounds on structural dimensions. The optimization procedure used by PARS is based on a mathematical programming method employing a sequence of unconstrained minimization techniques in which design requirements are incorporated using an extended interior penalty function approach. Approximate analysis techniques, design variable linking, constraint deletion, and approximate expressions for constraint function second derivatives are used in conjunction with Newton's method to reduce computational time and increase the order of the structural design problem that can be solved. This optimization technique may be automatically invoked for both static and flutter optimization tasks. In addition, PARS may be used to automatically obtain a fully stressed design when the structure is subject only to stress constraints. The user has the option of developing his own optimization loops by calling the processors in a user defined sequence. The PARS program was developed to work in conjunction with the SPAR system. Input to PARS consists of the SPAR finite element model of the structure, the design constraints, and the PARS control parameters. Output from the PARS programs includes a complete resized finite element model, optimization history, and selected structural parameters. The PARS program is written in FORTRAN IV for batch execution and has been implemented on a CDC CYBER 70 series computer under control of NOS 1.3. The PARS program has a central memory requirement of approximately 70K (octal) of 60 bit words. The

PARS user must have access to the SPAR system. The PARS program was developed in 1979.

43 EARTH RESOURCES

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography*.

M80-10029* National Aeronautics and Space Administration. Earth Resources Lab., Slidell, La.

WATER SEARCH PROGRAM

FORTRAN IV (90 percent), ASSEMBLER (10 percent) 7,266 source statements

VARIAN 70

ERL-10010 Price: Program $650.00/Documentation $11.00

One of the important applications of Earth resources analysis utilizing multispectral data is the location and classification of water resources. The Water Search Program was developed to aid the resource analyst in just this task. This task can be quite difficult since there is no single spectral signature for water as found on the surface of the Earth. Normally, surface water has varying concentrations of dissolved pigments and suspended particles which result in a wide range of spectral values as viewed from a remote sensor. Each of these concentrations may vary continuously, so that it may not be possible to define discrete classes of water with precision. Rough divisions can be made into classes such as clear ocean water, turbid coastal water, clear lake water, turbid lake water, and river water. The problem with these rough divisions is that they may not be mutually exclusive or inclusive. The classification is further complicated by the picture elements which are part land and part water, bottom visibility in shallow waters, and sun glint. The Water Search Program performs a rapid discrimination between water and all other materials using just two channels of multispectral data. The first channel of discrimination is in the near infrared region of the spectrum. Cover vegetation and bare soil are usually highly reflective at this wavelength whereas water absorbs strongly in the infrared. Visible light in the green area of the spectrum penetrates water much easier than the infrared. Thus the green light is backscattered by the suspended particles. The green signal is more sensitive to changes in concentrations of suspended particles than the infrared signal. Variation of concentration of suspended particles causes the intensities in the green and infrared to vary smoothly without varying the ratio of band to band intensities significantly. The behavior of land targets is quite different. The spectral behaviors of the green and infrared signals can be used to build a decision curve. For a given image the classification is performed by defining an area in the sense which represents water. This is accomplished by examining scenes where the water boundaries are known and modifying the decision curve until the known boundaries are displayed correctly. The resulting decision curve is then used to discriminate water from all other materials for the entire frame of data. In cases where other materials such as shadows might be misidentified as water, a maximum likelihood ratio algorithm may be used for further classification. This program is written in FORTRAN IV and ASSEMBLER for interactive execution and has been implemented on a VARIAN 70 series computer with a central memory requirement of approximately 67K (octal). The program is designed for use with the COMTAL image processing system. The Water Search Program was developed in 1977.

61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, and algorithms.

M80-10030* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

AN EVALUATION OF REGISTRATION, COMPRESSION, AND CLASSIFICATION ALGORITHMS

FORTRAN IV 8,715 source statements

IBM 360

MFS-25367 Price: Program $970.00/Documentation $28.00

Several types of algorithms are generally used to process digital imagery such as LANDSAT data. The most commonly used algorithms perform the task of registration, compression, and classification. Because there are different techniques available for performing registration, compression, and classification, imagery data users need a rationale for selecting a particular approach to meet their particular needs. This collection of registration, compression, and classification algorithms was developed so that different approaches could be evaluated and the best approach for a particular application determined. Routines are included for six registration algorithms, six compression algorithms, and two classification algorithms. The package also includes routines for evaluating the effects of processing on the image data. This collection of routines should be useful to anyone using or developing image processing software. Registration of image data involves the geometrical alteration of the imagery. Registration routines available in the evaluation package include image magnification, mapping functions, partitioning, map overlay, and data interpolation. The compression of image data involves reducing the volume of data needed for a given image. Compression routines available in the package include adaptive differential pulse code modulation, two dimensional transforms, clustering, vector reduction, and picture segmentation. Classification of image data involves analyzing the uncompressed or compressed image data to produce inventories and maps of areas of similar spectral properties within a scene. The classification routines available include a sequential linear technique and a maximum likelihood technique. The choice of the appropriate evaluation criteria is quite important in evaluating the image processing functions. The user is therefore given a choice of evaluation criteria with which to investigate the available image processing functions. All of the available evaluation criteria basically compare the observed results with the expected results. For the image reconstruction processes of registration and compression, the expected results are usually the original data or some selected characteristics of the original data. For classification processes the expected result is the ground truth of the scene. Thus, the comparison process consists of determining what changes occur in processing, where the changes occur, how much change occurs, and the amplitude of the change. The package includes evaluation routines for performing such comparisons as average uncertainty, average information transfer, chi-square statistics, multidimensional histograms, and computation of contingency matrices. This collection of routines is written in FORTRAN IV for batch execution and has been implemented on an IBM 360 computer with a central memory requirement of approximately 662K of 8 bit bytes. This collection of image processing and evaluation routines was developed in 1979.

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

M80-10031 Rockwell International Corp., Downey, Calif.

EQNINT: EQUATIONS INTERPRETER PROGRAM IN PL/1

PL/1 572 source statements

IBM 370

MSC-18672 Price: Program $50.00/Documentation $4.00

The equations interpreter program EQNINT was developed for programming applications in which it is desired to input equations as data. The ability to input equations as data can be very useful in situations where it is required that equations be changed often for testing and where recompilation after each change would be time consuming and costly. The EQNINT program

accepts as input any equation written in standard algebraic (FORTRAN-like) format. Symbols used in the equation are interpreted in terms of a user defined array in the EQNINT program. This program is written in PL/1 for batch execution and has been implemented on an IBM 370 computer with a central memory requirement of approximately 35K of 8 bit bytes. The EQNINT program was developed in 1979.

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

M80-10032* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
BIVARIATE NORMAL CONDITIONAL AND RECTANGLE PROBABILITIES
FORTRAN IV 305 source statements
CDC-6000
FRC-11057 Price: Program/Documentation $25.00

This computer program was developed to compute the conditional and rectangular probabilities of a bivariate normal distribution. In applications involving univariate data where estimates and confidence intervals are required, the normal distribution is routinely employed. This distribution is widely utilized because the probabilities under a normal curve are readily available. In contrast, applications of multivariate normal distributions are much less frequent, primarily because probabilities for the special cases, the probabilities for sections of multidimensional space require extensive computations due to the fact that the canonical multivariate normal density changes with every change in correlation coefficient parameters. This program can be used to determine bivariate probabilities in many applications involving multivariate data. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6000 series computer with a central memory requirement of approximately 25K (octal) of 60 bit words. This program was developed in 1979.

72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure and molecular spectra

M80-10033* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
POSTRN: PROGRAM FOR CALCULATING ENERGY AND TRANSIT TIMES OF POSITRONS
FORTRAN IV 459 source statements
CDC CYBER 170
LAR-12707 Price: Program $140.00/Documentation $10.00

Studies have shown that positron lifetime in composite materials is a linear function of the moisture content of the material. This inforamtion could be used to determine the moisture profile in composite components. This moisture profile is an important factor in determining the degree of environmental degradation which has occured in the composite. The POSTRN program was developed to aid in optimizing a positron magnetic analysis system which could be utilized in the study of composite moisture profiles. The ability to measure moisture profile nondestructively has significant potential value because the continual absorption and desorption of moisture usually results in unpredictable and highly nonuniform moisture profiles. The use of magnetically analyzed positrons can be of practical interest only if the spread in their arrival time at the target is less than the time resolution of the lifetime measurement system and their energy resolution is better than their range definition in the target. The POSTRN program can be used to calculate the various experimental parameters needed for maximizing the number of energy-analyzed positrons arriving at the target, while minimizing the spread in their energy and arrival time. The POSTRN program basically analyzes the trajectory of a positron beam through a collimator and magnetic field, then analyzes the energy and time spread at the target. Input to POSTRN consists of collimator focusing energy, target placement data, target size, and number of positrons to be generated. Output includes the number of target hits, their energy spread, and the corresponding time spread. The POSTRN program is written in FORTRAN IV for batch execution and has been implemented on a CDC CYBER 170 computer with a central memory requirement of approximately 60K (octal) of 60 bit words. The POSTRN program was developed in 1979.

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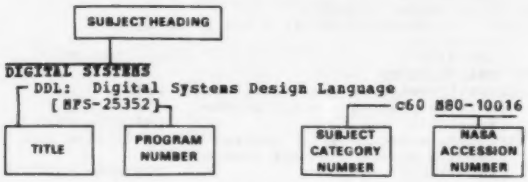

The subject heading is a key to the subject content of the document. The titles, with title extensions if present, are arranged under each subject heading in ascending accession number order. The program number is the number assigned in the COSMIC inventory to identify the coded source. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category.

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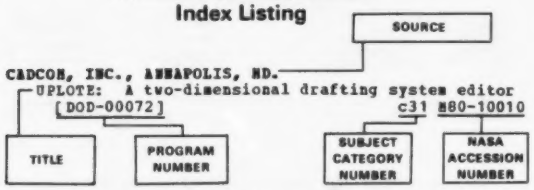

Listings in this index are arranged alphabetically by originating source. The title of the document provides the user with a brief description of the subject matter. The program number is the number assigned in the COSMIC inventory to identify the coded source. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category. The titles are arranged under each corporate source in ascending accession number order.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. HUGH L. DRYDEN FLIGHT RESEARCH CENTER, EDWARDS, CALIF.
Bivariate normal conditional and rectangle probabilities
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PROGRAM/ACCESSION NUMBER INDEX

Typical Program/Accession Number Index Listing

Listings in this index are arranged alphanumerically by program number. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category. An asterisk (*) indicates NASA support.

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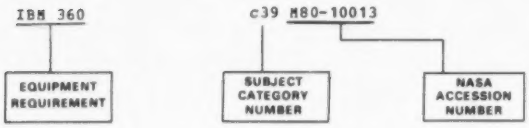

Equipment requirements are arranged in alphanumeric sequence. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category.

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Computer Program Abstracts

OCTOBER 15, 1980

VOLUME 12 • NUMBER 3

M80-10034—M80-10067

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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INTRODUCTION

Computer Program Abstracts is an indexed journal containing abstracts of documented computer programs developed by the National Aeronautics and Space Administration, NASA contractors, and other Federal Agencies, which are offered for sale through the NASA sponsored Computer Software Management and Information Center (COSMIC) located at the University of Georgia.

Computer Program Abstracts is published quarterly by the National Aeronautics and Space Administration and is organized into five sections. The first section contains program citations and abstracts arranged in ten major divisions divided into seventy-four specific subject categories and one general category/division. Following are four sections of indexes: subject, originating source, program number/accession number, and equipment requirements.

The Subject Index is an alphabetical listing of the main subject headings by which the computer programs have been identified.

The Originating Source Index is an alphabetical listing of the names of organizations responsible for the computer programs contained in the journal.

The Program Number/Accession Number Index provides a cross-index from the program number assigned in the COSMIC inventory to identify coded source and sequence to the corresponding accession number assigned sequentially to abstracts in *Computer Program Abstracts*.

The Equipment Requirements Index comprises an alphanumeric listing of the kinds of equipment required for the use of the computer programs included in the journal.

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The University of Georgia
Athens, Georgia 30602
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AERONAUTICS

Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics*.

01 AERONAUTICS (GENERAL) **N.A.**

02 AERODYNAMICS **15**

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer*.

03 AIR TRANSPORTATION AND SAFETY **N.A.**

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation*.

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION **N.A.**

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Spacecraft Communications, Command and Tracking* and *32 Communications*.

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE **N.A.**

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.

06 AIRCRAFT INSTRUMENTATION **N.A.**

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography*.

07 AIRCRAFT PROPULSION AND POWER **16**

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion*.

08 AIRCRAFT STABILITY AND CONTROL **N.A.**

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

09 RESEARCH AND SUPPORT FACILITIES (AIR) **17**

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

For related information see also *14 Ground Support Systems and Facilities (Space)*.

ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

For related information see also *Aeronautics*.

12 ASTRONAUTICS (GENERAL) **N.A.**

For extraterrestrial exploration see *91 Lunar and Planetary Exploration*.

13 ASTRODYNAMICS **N.A.**

Includes powered and free-flight trajectories; and orbit and launching dynamics.

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE) **N.A.**

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air)*.

15 LAUNCH VEHICLES AND SPACE VEHICLES **N.A.**

Includes boosters; manned orbital laboratories; reusable vehicles; and space stations.

16 SPACE TRANSPORTATION **17**

Includes passenger and cargo space transportation, e.g., shuttle operations; and rescue techniques.

For related information see also *03 Air Transportation and Safety* and *85 Urban Technology and Transportation*.

17 SPACECRAFT COMMUNICATIONS, COMMAND AND TRACKING **N.A.**

Includes telemetry; space communications networks; astronavigation; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications*.

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE **N.A.**

Includes spacecraft thermal and environmental control; and attitude control.

For life support systems see *54 Man/System Technology and Life Support*. For related information see also *05 Aircraft Design, Testing and Performance* and *39 Structural Mechanics*.

19 SPACECRAFT INSTRUMENTATION 18

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography*.

20 SPACECRAFT PROPULSION AND POWER N.A.

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion*.

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

23 CHEMISTRY AND MATERIALS (GENERAL) N.A.

Includes biochemistry and organic chemistry.

24 COMPOSITE MATERIALS N.A.

Includes laminates.

25 INORGANIC AND PHYSICAL CHEMISTRY N.A.

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics*.

26 METALLIC MATERIALS N.A.

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

27 NONMETALLIC MATERIALS N.A.

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

28 PROPELLANTS AND FUELS N.A.

Includes rocket propellants, igniters, and oxidizers; storage and handling; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion*.

ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

For related information see also *Physics*.

31 ENGINEERING (GENERAL) N.A.

Includes vacuum technology; control engineering; display engineering; and cryogenics.

32 COMMUNICATIONS N.A.

Includes land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Spacecraft Communications, Command and Tracking*.

33 ELECTRONICS AND ELECTRICAL ENGINEERING 18

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics*.

34 FLUID MECHANICS AND HEAT TRANSFER N.A.

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics*.

35 INSTRUMENTATION AND PHOTOGRAPHY N.A.

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources*. For related information see also *06 Aircraft Instrumentation* and *19 Spacecraft Instrumentation*.

36 LASERS AND MASERS N.A.

Includes parametric amplifiers.

37 MECHANICAL ENGINEERING N.A.

Includes auxiliary systems (non-power); machine elements and processes; and mechanical equipment.

38 QUALITY ASSURANCE AND RELIABILITY 21

Includes product sampling procedures and techniques; and quality control.

39 STRUCTURAL MECHANICS 21

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance*.

GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

For related information see also *Space Sciences*.

42 GEOSCIENCES (GENERAL) N.A.

43 EARTH RESOURCES **N.A.**

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography*.

44 ENERGY PRODUCTION AND CONVERSION **23**

Includes specific energy conversion systems, e.g., fuel cells and batteries; global sources of energy; fossil fuels; geophysical conversion; hydroelectric power; and wind power.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *85 Urban Technology and Transportation*.

45 ENVIRONMENT POLLUTION **N.A.**

Includes air, noise, thermal and water pollution; environment monitoring; and contamination control.

46 GEOPHYSICS **N.A.**

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation*.

47 METEOROLOGY AND CLIMATOLOGY **N.A.**

Includes weather forecasting and modification.

48 OCEANOGRAPHY **N.A.**

Includes biological, dynamic and physical oceanography; and marine resources.

LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

51 LIFE SCIENCES (GENERAL) **N.A.**

Includes genetics.

52 AEROSPACE MEDICINE **N.A.**

Includes physiological factors; biological effects of radiation; and weightlessness.

53 BEHAVIORAL SCIENCES **N.A.**

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT **N.A.**

Includes human engineering; biotechnology; and space suits and protective clothing.

55 PLANETARY BIOLOGY **N.A.**

Includes exobiology; and extraterrestrial life.

MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL) **N.A.**

60 COMPUTER OPERATIONS AND HARDWARE **N.A.**

Includes computer graphics and data processing.

For components see *33 Electronics and Electrical Engineering*.

61 COMPUTER PROGRAMMING AND SOFTWARE **23**

Includes computer programs, routines, and algorithms.

62 COMPUTER SYSTEMS **24**

Includes computer networks.

63 CYBERNETICS **N.A.**

Includes feedback and control theory.

For related information see also *54 Man/System Technology and Life Support*.

64 NUMERICAL ANALYSIS **N.A.**

Includes iteration, difference equations, and numerical approximation.

65 STATISTICS AND PROBABILITY **24**

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

66 SYSTEMS ANALYSIS **N.A.**

Includes mathematical modeling; network analysis; and operations research.

67 THEORETICAL MATHEMATICS **N.A.**

Includes topology and number theory.

PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

For related information see also *Engineering*.

70 PHYSICS (GENERAL) **N.A.**

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71 ACOUSTICS 24
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For noise pollution see *45 Environment Pollution*.

72 ATOMIC AND MOLECULAR PHYSICS N.A.
Includes atomic structure and molecular spectra.

73 NUCLEAR AND HIGH-ENERGY PHYSICS N.A.
Includes elementary and nuclear particles; and reactor theory.
For space radiation see *93 Space Radiation*.

74 OPTICS N.A.
Includes light phenomena.

75 PLASMA PHYSICS N.A.
Includes magnetohydrodynamics and plasma fusion.
For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

76 SOLID-STATE PHYSICS N.A.
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For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers*.

77 THERMODYNAMICS AND STATISTICAL PHYSICS 25
Includes quantum mechanics; and Bose and Fermi statistics.
For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer*.

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

80 SOCIAL SCIENCES (GENERAL) N.A.
Includes educational matters.

81 ADMINISTRATION AND MANAGEMENT N.A.
Includes management planning and research.

82 DOCUMENTATION AND INFORMATION SCIENCE N.A.
Includes information storage and retrieval technology; micrography; and library science.
For computer documentation see *61 Computer Programming and Software*.

83 ECONOMICS AND COST ANALYSIS N.A.
Includes cost effectiveness studies.

84 LAW AND POLITICAL SCIENCE N.A.
Includes space law; international law; international cooperation; and patent policy.

85 URBAN TECHNOLOGY AND TRANSPORTATION 25
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.
For related information see *03 Air Transportation and Safety*, *16 Space Transportation*, and *44 Energy Production and Conversion*.

SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.
For related information see also *Geosciences*.

88 SPACE SCIENCES (GENERAL) N.A.

89 ASTRONOMY N.A.
Includes radio and gamma-ray astronomy; celestial mechanics; and astrometry.

90 ASTROPHYSICS N.A.
Includes cosmology; and interstellar and interplanetary gases and dust.

91 LUNAR AND PLANETARY EXPLORATION N.A.
Includes planetology; and manned and unmanned flights.
For spacecraft design see *18 Spacecraft Design, Testing and Performance*. For space stations see *15 Launch Vehicles and Space Vehicles*.

92 SOLAR PHYSICS N.A.
Includes solar activity, solar flares, solar radiation and sunspots.

93 SPACE RADIATION N.A.
Includes cosmic radiation; and inner and outer earth's radiation belts.
For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

GENERAL

99 GENERAL N.A.

Note: N.A. means that no abstracts were assigned to this category for this issue.

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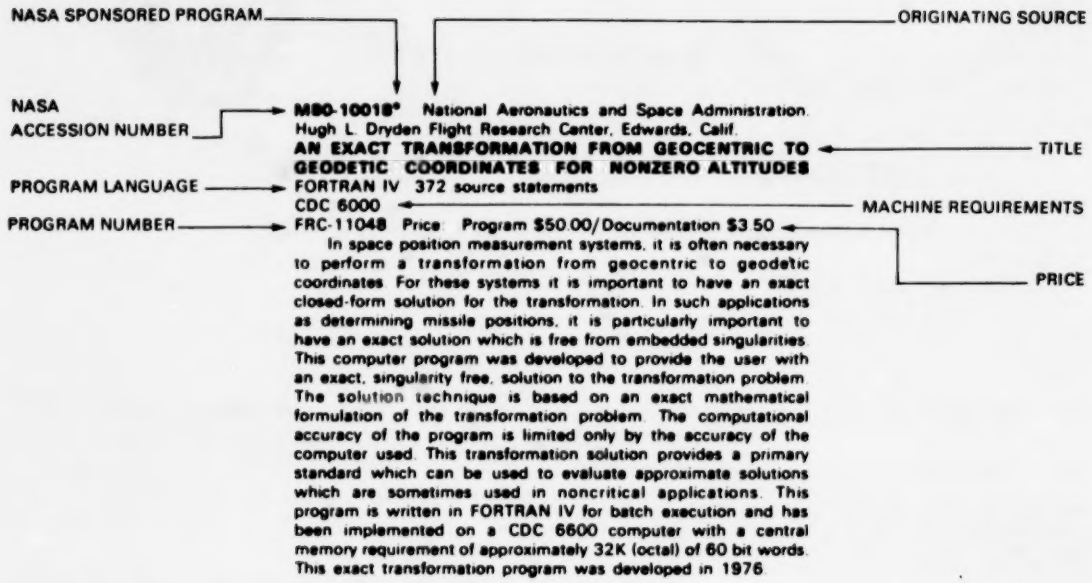
TYPICAL CITATION AND ABSTRACT


NASA SPONSORED PROGRAM
ORIGINATING SOURCE
NASA ACCESSION NUMBER
MSC-10018* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
AN EXACT TRANSFORMATION FROM GEOCENTRIC TO GEODETIC COORDINATES FOR NONZERO ALTITUDES
TITLE
PROGRAM LANGUAGE
FORTRAN IV 372 source statements
CDC 6000
MACHINE REQUIREMENTS
PROGRAM NUMBER
FRC-11048 Price: Program $50.00/Documentation $3.50
PRICE
In space position measurement systems, it is often necessary to perform a transformation from geocentric to geodetic coordinates. For these systems it is important to have an exact closed-form solution for the transformation. In such applications as determining missile positions, it is particularly important to have an exact solution which is free from embedded singularities. This computer program was developed to provide the user with an exact, singularity free, solution to the transformation problem. The solution technique is based on an exact mathematical formulation of the transformation problem. The computational accuracy of the program is limited only by the accuracy of the computer used. This transformation solution provides a primary standard which can be used to evaluate approximate solutions which are sometimes used in noncritical applications. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6600 computer with a central memory requirement of approximately 32K (octal) of 60 bit words. This exact transformation program was developed in 1976.

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02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

M80-10034* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AEROELASTIC ANALYSIS FOR ROTORCRAFT IN FLIGHT OR IN A WIND TUNNEL
FORTRAN IV 13,793 source statements
IBM 360
ARC-11150 Price: Program $1200.00/Documentation $28.50

The testing of rotorcraft, either in flight or in a wind tunnel, requires a consideration of the coupled aeroelastic stability of the rotor and airframe, or the rotor and support system. Even if the primary purpose of a test is to measure rotor performance, ignoring the question of dynamic stability introduces the risk of catastrophic failure of the aircraft. This computer program was developed to incorporate an analytical model of the aeroelastic behavior of a wide range of rotorcraft. Such an analytical model is desirable for both pre-test predictions and post-test correlations. The program is also applicable in investigations of isolated rotor aeroelasticity and helicopter flight dynamics and could be employed as a basis for more extensive investigations of aeroelastic behavior, such as automatic control system design. The program incorporates an analytical model which is applicable to a wide range of rotors, helicopters, and operating conditions. The equations of motion used in the model were derived using an integral Newtonian method, which provides considerable insight into the blade inertial and aerodynamic forces. The rotor model includes coupled flap-lag bending and blade torsion degrees of freedom, and is applicable to articulated, hingeless, gimballed, and teetering rotors with an arbitrary number of blades. The aerodynamic model is valid for both high and low inflow, and for both axial and nonaxial flight. Rotor rotational speed dynamics, including engine inertia and damping, and perturbation inflow dynamics are included in the aerodynamic model. For a rotor on a wind tunnel support, a normal mode representation of the test module, strut, and balance is used. The aeroelastic analysis for rotorcraft in flight is applicable to a general two-rotor aircraft, including single main-rotor and tandem helicopter configurations, and side-by-side or tilting proprotor aircraft configurations. The rotor model includes rotor-rotor aerodynamic interference and ground effect. The aircraft model includes rotor-fuselage-tail aerodynamic interference, engine dynamics, and control dynamics. A constant-coefficient approximation is used for nonaxial flow and a quasistatic approximation is used for the low frequency dynamics. The coupled system dynamics results in a set of linear differential equations which are used to determine the stability and aeroelastic response of the system. This program is written in FORTRAN IV for batch execution and has been implemented on an IBM 360 series computer with a central memory requirement of approximately 624K of 8 bit bytes. This program was developed in 1977.

M80-10035* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AIRCL: A PROGRAMMED SYSTEM FOR GENERATING NUMERICAL CONTROL TAPES FOR AIRPLANE MODELS
FORTRAN IV (88 percent), COMPASS (12 percent) 5,294 source statements Prepared in cooperation with Battelle Memorial Inst., Columbus, Ohio
CDC 6000
LAR-12494 Price: Program $650.00/Documentation $8.00

Early in the design of advanced aircraft configurations, it is usually desirable to construct scale models for wind tunnel testing. The advent of numerically controlled machine tools has greatly simplified the task of machining these scale models. However, the data required by the machine tool is different than the configuration data with which the designer usually works. The AIRCL program was developed to accept configuration data in terms of coordinates on the fuselage bulkheads and wing chords and to determine the cutter locations needed to machine the configuration. The output from AIRCL is file formatted to imitate the Cutter Location (CL) output of CDC's APT 3 compiler. This permits the output to be post-processed for a specific machine tool. The AIRCL program is written in FORTRAN IV and COMPASS for batch execution and has been implemented on a CDC CYBER 70 series computer with a central memory requirement of approximately 126K (octal) of 60 bit words. The AIRCL program was developed in 1978.

M80-10036 Grumman Aerospace Corp., Bethpage, N.Y.
WIBCO: WING BODY CODE FOR TRANSONIC FLOW FIELD ANALYSIS OF WING-FUSELAGE CONFIGURATIONS
FORTRAN IV 11,707 source statements
CDC CYBER 170
LAR-12702 Price: Program $1200.00/Documentation $18.50

The inherent complexity of transonic flow renders a pure experimental approach to solving aircraft design problems in this regime impractical in many cases. The transonic flow field is characterized by mixed subsonic and supersonic regions, shock waves, and complicated viscous effects. The Wing Body Code (WIBCO) was developed for simulating the aerodynamics of wing-fuselage configurations at transonic speeds. The WIBCO finite difference scheme is characterized by a multiple embedded mesh system coupled with a modified extended small-disturbance flow equation. This approach permits a high degree of computational resolution in addition to coordinate system flexibility for treating complex realistic aircraft shapes. The WIBCO program should prove useful in reducing the design cost and improving the performance of high speed aircraft. The flow equation employed by WIBCO is a modified extension of the classical transonic small-disturbance equation. This modification includes cross flow terms which permit the resolution of shock waves with large sweep angles. The computational space used in solving the flow equation is divided into a global crude grid and embedded fine grids about the wing and body where the gradients are

large and the details important. The resulting numerical efficiency permits a very dense computational mesh, a benefit in both the resolution of shock waves and the calculation of configuration forces and moments. The embedded mesh systems are independent and optimized for a particular geometric component, thus facilitating applications to complex configurations. The flow field equation is solved using a finite difference approximation with enforced boundary conditions. A successive line over-relaxation method is used where vertical columns of mesh points are relaxed starting at the first point upstream and ending at the last point downstream in each grid system. Input to the WIBCO program consists of ambient flow conditions, geometric configuration data, and grid control parameters. Output includes input data echo, grid system verification, relaxation solution convergence history, and computed velocities, pressures, forces, moments, reference lengths and areas. Plotted output for geometry verification is also available. Plotted output can be generated for any off-line X-Y type plotter. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC CYBER 175 with a central requirement of approximately 226K (octal) of 60 bit words. The WIBCO program was developed in 1980.

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

M80-10037 SKF Industries, Inc., King of Prussia, Pa.
CYBEAN: HIGH SPEED CYLINDRICAL ROLLER BEARING ANALYSIS
FORTRAN IV 14,201 source statements
UNIVAC 1100
LEW-13393 Price: Program $1900.00/Documentation $24.00

Engine performance which satisfies the anticipated efficiency, speed, and specific thrust requirements for aircraft in the coming decade places increased demands on the performance of engine components. Engines will be required to operate at high temperatures and speeds while maintaining low overall mass and high structural integrity. Bearings in particular emerge as critical system design elements for the new engines. The high speed cylindrical roller bearing analysis program (CYBEAN) was developed to compute the behavior of cylindrical rolling element bearings under high speed and misaligned shaft conditions. With CYBEAN, an accurate assessment of geometry-induced roller preload is possible for a variety of outer ring and housing configurations and loading conditions. CYBEAN enables detailed examination of bearing performance and permits exploration of the causes and consequences of bearing skew. CYBEAN provides a general capability for the design assessment of bearings for engine mainshaft support. CYBEAN is structured as a bearing analysis tool involving the coordinated execution of modules which perform specific analytic tasks. The bulk of the calculations performed by CYBEAN consist of the repetitive computation of displacements and forces resulting from solid-solid and solid-fluid interactions. These interactions are permitted to occur in a thermally varying environment and are viewed as part of a system in quasi-static thermodynamic equilibrium. The system is defined by geometric and material descriptions of the bearing complement and the rheology of the lubricant used. The system is considered to be driven by external forcing functions which consist of a constant vector set representing definitions of shaft rotation, speed, and applied radial force. Additional system stimulation is accepted from heat generated within the boundaries of the defined system volume. Once geometry and material properties are defined, specific interaction mechanisms are used to determine the force equilibrium field equation set. Solid-solid interactions are used to calculate contact stresses, contact sizes, and associated elastic forces. Solid-fluid interactions are used to determine raceway/rolling element tractions, flange/rolling element tractions, roller drags, and cage related frictions. The completion of the detailed interaction mechanisms allows the generation of the quasi dynamic force equilibrium equations. A Newton-Raphson iterative procedure is used to solve the equation set. A Lundberg-Palmgren method is employed to compute the bearing fatigue life. Thermal effects on the system may be computed in either a steady state or transient mode. Input to CYBEAN consists of bearing geometry, material properties, and imposed operating conditions. Output includes evaluated lubricant data, geometric and fit information, cage forces, speeds, maximum contact stresses, lubricant film thicknesses, angular roller rotations detailing tilt and skew, and the temperature distribution for the complete nodal network. The CYBEAN program is written in FORTRAN IV for batch execution and has been implemented on a UNIVAC 1100 computer with a segmented central memory requirement of approximately 91K of 36 bit words. The CYBEAN program was developed in 1978.

M80-10038* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TWO-DIMENSIONAL POTENTIAL FLOW THROUGH DEFLECTED NOZZLES
FORTRAN IV 9,254 source statements
LEW-13461 Price: Program $1000.00/Documentation $17.50

Many of the proposed V/STOL aircraft require propulsion systems which deflect the thrust during takeoff, landing, and hovering. One of the proposed methods for accomplishing this deflection is by the use of flow turning nozzles downstream from the propulsion system fans. These nozzles must operate efficiently and effectively over wide ranges of internal flow conditions. This set of computer programs was developed to calculate the two dimensional potential flow through deflected nozzles as an aid in designing efficient nozzles. Although the proposed V/STOL nozzles are three dimensional, the capability for a full three dimensional nozzle analysis does not currently exist. These programs perform a two dimensional analysis which can provide an informative approximation for certain sections of a nozzle. As an aid in analyzing the flow conditions through deflected nozzles, this set of programs can be used to calculate the incompressible potential flow, corrected for compressibility, in two dimensional nozzles over a wide range of operating conditions. The SCIRCL program takes user supplied nozzle geometry data and prepares coordinate-point, rake-point, and control station data for use in the other programs. The 24Y program is the Douglas incompressible potential flow program for single and multiple two dimensional bodies. The 24Y program is used to obtain a basic set of potential flow solutions for a small, prescribed set of operating conditions. The solutions obtained from 24Y are used by the NOZZLEC program to obtain the potential flow for any desired solution of interest. A solution of interest is one having specified values of free stream velocity, angle-of-attack of freestream, and weight flow through the control stations. The NOZZLEC program also incorporates a compressibility correction and an optional supersonic correction. Output from NOZZLEC includes a full parametric description of the computed potential flow for the solution of interest. These three programs are written in FORTRAN IV for batch execution and have been implemented on a UNIVAC 1100 series computer with a central memory requirement of approximately 64K of 36 bit words. This two dimensional potential flow analysis system was developed in 1979.

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

For related information see also *14 Ground Support Systems and Facilities (Space).*

M80-10039* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
TWINTAN: A TRANSONIC WALL INTERFERENCE ANALYSIS METHOD
FORTRAN IV 766 source statements
CDC CYBER 170
LAR-12753 Price: Program $140.00/Documentation $8.50

Classical methods for evaluating wind tunnel wall interference are generally unsatisfactory for use with wind tunnels for two major reasons. The first reason is that it has not been possible to define the boundary conditions for slotted or perforated walls with the required generality and accuracy. The second reason is that the principle of linear superposition on which the classical approach is based becomes invalid at transonic speeds. This computer program, TWINTAN, was developed to implement a new method of post-test assessment of wall interference which overcomes these classical problems for two dimensional wind tunnel applications. The method used by TWINTAN involves the successive solution of the transonic small disturbance potential equation for computation of the wind tunnel flow, the perturbation attributable to the model, and the equivalent free air flow around the model. The total procedure employed by TWINTAN can be considered as a nonlinear counterpart of classical wall interference theory with the effects of both viscosity and tunnel wall constraint being introduced through experimentally measured boundary conditions. These boundary conditions are developed from pressure distribution measurements made on the model and the tunnel walls. The corrected far field Mach number is calculated during the model perturbation solution. The wall induced perturbation field is taken as the difference between the model perturbation and the total perturbation in the tunnel flow solution. A correction for angle of attack is determined during the equivalent free air solution. The influence of nonuniformities in the wall induced velocity field are determined by comparing the equivalent free air pressure distribution with the experimental distribution adjusted to the new reference Mach number. The TWINTAN program is written in FORTRAN IV for batch execution and has been implemented on a CDC CYBER 175 computer with a central memory requirement of approximately 41K (octal) of 60 bit words. It is expected that the achievement of optimal accuracy and convenience will require modifications to the program as well as the instrumentation and data system at each installation site. This program was developed in 1977 with refinements being added in 1980.

M80-10040* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
GSE: GENERAL GROUND SUPPORT EQUIPMENT SOFTWARE SYSTEM
MACRO II (98 percent), FORTRAN (2 percent) 28,000 source statements
DEC PDP-11
GSC-12536 Price: Program $2180.00/Documentation $93.00

This ground support equipment system supports the development, calibration, and integration of scientific experiments. It can also be used for post launch quick-look processing and for data analysis. The general ground support equipment software system (GSE) was developed as a command and data aquisition system which will accomplish these ground support equipment tasks. Facilities to command the GSE system, to command scientific instruments, and to configure the system for different operational environments are provided through the Experiment Command Interactive Language (ECIL). ECIL is a versatile, interactive, procedural control language which was designed for the aerospace laboratory environment. The user of the GSE system can interact with incoming telemetry data, perform computations, and control execution of ECIL procedures. Procedures provide the timely execution of commands and assure repeatability of system actions. The GSE system is intended for use in developing complex instruments. Most instruments, especially spaceborne ones, must be vigorously tested to assure that functional performance levels meet required specifications. Consequently, instruments must be calibrated against known data sources. Once the instrument is calibrated, the electronics package must be placed in the final instrument enclosure and the launch vehicle. Once the instrument is spaceborne, the behavior of the instrument when subjected to severe environmental conditions must be analyzed quickly. These complex processes can be monitored and supported by the GSE system which records all of the data obtained for later processing. This generalized ground support equipment software system was developed to be 'configurable' to different specific instruments. By using a general approach, different instruments can be supported by GSE systems which are either derived from or are extensions of the general version. The overriding design criterion in developing the GSE system was that system implementation would require minimal modification for the maximum number of applications. The GSE system is written in MACRO II and FORTRAN for implementation on a DEC PDP-11/43 using the RSX-11M operating system. GSE has a minimum central memory requirement of approximately 42K of 16 bit words. This GSE system was developed in 1979.

16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation e.g., shuttle operations; and rescue techniques.

For related information see also *03 Air Transportation and Safety* and *85 Urban Technology and Transportation.*

M80-10041 Rockwell International Corp., Pittsburgh, Pa.
ORBITAL DEPLOYMENT PLOTTING PROGRAMS
HP BASIC 500 source statements
HP9830A
MSC-18614 Price: Program/Documentation $45.00

One of the most beneficial applications of the United States Space Program has been the observation of the Earth from orbiting satellites. The continuing development of new and improved sensors and high quality optical systems makes possible the observation and measurement of environmental phenomena from space in large quantities and in great detail. The advent of the space shuttle system should greatly reduce the cost and enhance the reliability of deploying Earth observation spacecraft. This package contains two computer programs for calculating and plotting the various orbital parameters needed to evaluate the cost effective deployment of satellites from the orbiter. The calculated parameters include: Earth trace repetition vs. altitude; trace separation longitude vs. altitude; and swath half-width and field-of-view half-angle vs. mask angle. The generated plots can be used to determine orbits for optimum Earth coverage within constraints imposed by desired field of view, swath width, coverage time, and coverage cycle. The programs in this package are written in the Hewlett Packard Language for the HP 9830A and its associated X-Y plotter. These programs were written in 1979.

M80-10042 Abacus Programming Corp., Santa Monica, Calif.
CRTSIM: SHUTTLE CRT DISPLAY SIMULATOR
FORTRAN IV (95 percent), OS Assembler (5 percent) Prepared in cooperation with Rockwell International Corp., Pittsburgh
IBM 370
MSC-18872 Price: Program $310.00/Documentation $13.50

The shuttle CRT display simulator (CRTSIM) was developed to aid the user in designing and verifying graphic displays for use on the shuttle. The CRTSIM effectively models the function of the space shuttle's Display Electronics Unit (DEU). The CRTSIM reads the Format Control Words (FCW) describing a display, and produces a hard copy of the video display that would appear on the DEU. The CRTSIM processes FCW serially, branching

when instructed, using algorithms that accurately simulate the shuttle DEU. Input to CRTSIM consists of a set of FCW that describe the DEU operations required to form the display. The principal output of CRTSIM is an SC4020 plotter generated hard copy of a CRT image. The display is labeled and oriented in accordance with FSSR verification requirements. Certain features on the display may be highlighted by the use of 'bubbles'. The CRTSIM program is written in FORTRAN IV and OS ASSEMBLER for batch execution and has been implemented on an IBM 370 series computer with a central memory requirement of approximately 74K of 8 bit bytes. Graphic output is generated for an SC4020 plotting system. The CRTSIM program was developed in 1980.

M80-10043* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SSPTA: SIMPLIFIED SHUTTLE PAYLOAD THERMAL ANALYZER
FORTRAN IV (99 percent), Assembler (1 percent) 13,870 source statements
IBM 360
GSC-12638 Price: Program $1100.00/Documentation $29.00

The Simplified Shuttle Payload Thermal Analyzer program (SSPTA) was developed to aid in the evaluation of thermal design concepts of instruments to be flown in the space shuttle cargo bay. SSPTA consists of a collection of programs that are currently used in the thermal analysis of spacecraft and have been modified for quick, preliminary analysis of payloads. SSPTA includes a reduced math model of the shuttle cargo bay to simplify use of the program for payload analysis. One of the prime objectives in developing SSPTA was to create a program which was easy to use. With SSPTA, the user required input is simple and the user is free from many of the concerns of computer usage such as disk space handling, tape usage, and complicated program control. Although SSPTA was designed primarily to analyze shuttle payloads, it can easily be used to perform thermal analysis in other situations. SSPTA is comprised of a system of data files called 'bins', a master program, and a set of thermal subprograms. The bin system is a collection of disk files which contain data required by or computed by the thermal subprograms. SSPTA currently has the capability of handling 50 bins. The master program serves primarily as a manager for the bin system and its interaction with the thermal subprograms. Input to the master program consists of simple user commands which direct the data manipulation procedures, prepare the data for these procedures, and call the appropriate thermal subprograms. The subprograms of SSPTA are all based on programs which have been used extensively in the analysis of orbiting spacecraft and space hardware. Subprogram CONSHAD uses the user supplied geometric radiation model to compute black body view factors, shadow factors, and a description of the surface model. The subprogram WORKSHEET uses the surface model description, optical property data, and node assignment data to prepare input for SCRIPTF. Subprogram SCRIPTF computes the inverses of the infrared (IR) and ultraviolet (UV) radiation transfer equations; it also computes the radiation coupling between nodes in the thermal model. Subprogram ORBITAL uses the shadow tables to compute incident flux intensities on each surface in the geometric model. Subprogram ABSORB uses these flux intensities combined with the IR and UV inverses to compute the IR and UV fluxes absorbed by each surface. The radiation couplings from SCRIPTF and the absorbed fluxes from ABSORB are used by subprogram TTA to compute the temperature and power balance for each node in the thermal model. Output consists of tabulated data from each of the subprograms executed during a particular analysis. Due to the modular form of SSPTA, analyses may be run in whole or in part, and new subprograms may be added by the user. SSPTA is written in FORTRAN IV and ASSEMBLER for batch execution and has been implemented on an IBM 370 series computer with a central memory requirement of approximately 600K of 8 bit bytes. SSPTA was developed in 1977 and last updated in 1979.

M80-10044 Rockwell International Corp., Downey, Calif.
A TIME DOMAIN ANALYSIS OF FREE RESPONSES
FORTRAN IV 1,209 source statements
CDC CYBER 160
MSC-18673 Price: Program $310.00/Documentation $3.00

This computer program was developed to implement Ibrahim's time domain analysis of free decaying responses, augmented by the use of simple coherence functions to establish the validity of the identified modes. The program is intended to be used for analyzing responses of the space shuttle in order to identify component vibration modes, frequencies, and damping rates. These results can then be used to establish structure flutter margins. The program is applicable to all random or free decaying response data such as accelerations, displacements, or strains. The user supplied response data is used to compute the least squares error characteristic matrix for Ibrahim's time domain analysis and to compute the structural eigenvalues and eigenvectors. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC CYBER 253K (octal) of 60 bit words. This program was developed in 1979.

19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography*.

M80-10045* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
INTERPRETIVE COMPUTER SIMULATOR FOR THE NASA STANDARD SPACECRAFT COMPUTER-II
PASCAL 4,251 source statements
CDC CYBER 175
LAR-12603 Price: Program $480.00/Documentation $25.50

This Interpretive Computer Simulator (ICS) for the NASA Standard Spacecraft Computer-II (NSSC-II) was developed as a code verification and testing tool. The NSSC-II is basically an IBM System/360 with additional short (16 bit) and double (64 bit) precision instructions and a 32 bit floating point instruction set. The design of the ICS is general so that it could be used as an S/360 simulator. However, the ICS is intended for simulating the NSSC-II to verify and test flight software. The system is implemented with sixteen 32 bit general registers, four floating point registers, sixty-four storage protect registers, a 65K memory, a real time clock, an interval timer, and a checkpoint/restart capability. Input to the simulator consists of an executable load module for the NSSC-II. This load module may be generated on an IBM System/360 or by means of an included meta-assembler and linkage loader for the NSSC-II. The generated output provides, per instruction, a value trace, a time history, and the program status. This interpretive computer simulator for the NSSC-II is written in Pascal for batch execution and has been implemented on a CDC CYBER 175 computer with a NOS operating system. This program was developed in 1979.

33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics*.

M80-10046 M&S Computing, Inc., Huntsville, Ala.
MAPS2: CADAT SYSTEM MASK ANALYSIS PROGRAM
FORTRAN IV 7,081 source statements
Xerox SIGMA II
MFS-25054 Price: Program $770.00/Documentation $19.50

The CADAT System Mask Analysis Program (MAPS2) was developed as an automated software tool for the analysis of

integrated circuit mask design. The MAPS2 program may be used to perform numerous analysis functions including artwork verification, device identification, nodal analysis, capacitance calculation, and logic equation generation. For data base simplicity, MAPS2 operates on mask data which has been converted from its original form to orthogonal rectangles with identification numbers. MAPS2 will accept and automatically convert mask data in MAP, PRF, MANN, AIDS, and Banning Cell Library formats. The resultant rectangular mask data file allows MAPS2 to perform mask analysis tasks in a fast and efficient manner. Once the mask data file has been created, the user controls the analysis performed by MAPS2 through the use of a versatile command language. The user may command a wide range of mask analysis processes including qualitative and quantitative testing of selected mask areas, modification of masks, creation of new masks, and computation and sorting of mask data. The MAPS2 processing can be divided into two major processes: rectangular refinement and command execution. In the rectangular refinement processing, user supplied mask data is converted into the orthogonal rectangle format which will approximate the mask to any user specified accuracy. Once the rectangular mask data has been generated and stored, user supplied commands are processed one at a time. Data is read from the mask rectangle file, the requested processing is performed, output data files are generated, and any user requested information is printed. The MAPS2 program is written in FORTRAN IV for batch execution and has been implemented on a Xerox SIGMA II computer with a central memory requirement of approximately 33K of 16 bit words. The MAPS2 was developed in 1976.

M80-10047 M&S Computing, Inc., Huntsville, Ala.
LOGSIM: CADAT SYSTEM LOGIC SIMULATION PROGRAM
FORTRAN IV 4,634 source statements
Xerox SIGMA V
MFS-25183 Price: Program $650.00/Documentation $21.00

The CADAT system Logic Simulation program (LOGSIM) was developed as an automated software system for checking the functional correctness of an electronic logic circuit by simulating the operation of the circuit at the logic gate level. In addition to functional checking, LOGSIM checks the propagation delay through the various logic nets of a circuit and will indicate any timing or 'race' conditions which should be examined further by the system and logic designer. LOGSIM is capable of simulating very large logic networks within a modest amount of computer core memory. The program has an internal library of 15 logic element types to which the user may add new element types by simply defining their operation. In addition, the user may define complex logic functions in terms of read-only-memories with up to 15 inputs each. The LOGSIM program is divided into three phases: the preprocessor, the simulator, and the postprocessor. Each of the phases may be run independently or in a stream. The preprocessor validates the input data and provides diagnostic messages whenever necessary. The preprocessor generates a connectivity list showing each gate and its loads to aid the user in determining that the input data describes the circuit intended. The preprocessor also prepares a circuit data file for use by the simulator. The simulator first establishes the initial levels of each of the logic elements. Next, the user specified input signals are propagated through the circuit. Specified level changes are entered into an element status table. Each element loaded by the changed signals is then examined to determine if its output is changed. Appropriate logic delay and decay times are added to the current time to find the times at which future events are to be scheduled. When all loads have been examined, the current time is advanced to that of the next scheduled event and the process is repeated. As the new levels of each scheduled event are entered in the element status table, it is also recorded on an events tape for input to the postprocessor. The postprocessor reads the list of input circuit element names and the initial conditions, and prints a list of the signals to be output. A timing diagram may be printed with the initial condition of each element or a list of all initial conditions. Logic events are read from the simulator data tape and the status of the user selected elements are printed for each time within the specified interval at which an event occurs. The postprocessor is controlled by user directives and can generate any number of timing diagrams in any user specified format during a single run. In order for logic circuitry to be simulated on an ideal binary-valued basis, a relationship must be established between the ideal low and high levels and the delayed level transitions which occur in reality. The LOGSIM approach is to establish the switching time as the time when the gate in reality has switched nine-tenths of the change between levels. The rise and fall delay times are supplied by the user for each circuit element. Thus, LOGSIM simulates such occurences as logic fall decay of a MOS transmission gate and a logic spike condition. The LOGSIM program is written in FORTRAN IV for batch execution and has been implemented on a Xerox SIGMA V computer using the CP-5 operating system. Program central memory requirement is dependent on problem size and complexity with a 5000 logic gate circuit requiring approximately 50K of 32 bit work memory. The LOGSIM program was developed in 1972 and last updated in 1976.

M80-10048* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ARTWORK: THE CADAT SYSTEM INTEGRATED CIRCUIT ARTWORK PROGRAM
FORTRAN IV (5 percent), DATA (95 percent) 90,000 source statements
Xerox SIGMA V
MFS-25017 Price: Program $1900.00/Documentation $57.50

The CADAT system integrated circuit artwork program (ARTWORK) was developed to convert high level artwork data into actual mask patterns. The ARTWORK program can be used to generate plot commands for a Gerber 1200 plotter or for a MANN pattern generator. ARTWORK generates commands that select the appropriate apertures and completely expose, or 'fill-in', the specified areas of a circuit mask. The program generates the commands required to produce the artwork on a 'on-mask-at-a-time' basis with up to nine mask levels permitted. The generated pattern commands are written to tape, with each level being written in a separate file. In addition to creating the commands required to produce the artwork needed for fabrication of circuit masks, ARTWORK contains an extensive utility package. This utility capability enables the user to create new pattern libraries, develop new cells, incorporate new cells into the pattern library, and perform various system orientation functions such as pattern library display and tape handling. Included with the COSMIC distribution packages for ARTWORK is an extensive PMOS, CMOS, and SOS Pattern Library. The ARTWORK package offers the user a very versatile ready-to-use mask generation capability. The ARTWORK program is written in FORTRAN IV for batch execution and has been implemented on a Xerox SIGMA V computer with a central memory requirement of approximately 20K to 32 bit words. The ARTWORK program was developed in 1976.

M80-10049 Radio Corp. of America, New York.
PR2D: THE CADAT SYSTEM PLACE AND ROUTE IN TWO DIMENSIONS PROGRAM
FORTRAN IV 29,649 source statements
Xerox SIGMA V
MFS-25058 Price: Program $1750.00/Documentation $38.00

The CADAT System Place and Route in Two Dimensions program (PR2D) was developed as a standard cell automatic layout program for generating large scale integrated/metallic oxide semiconductor (LSI/MOS) arrays. The PR2D program performs the task of translating the logic designer's cell interconnection requirements into a physical definition of a MOS chip. Input data to PR2D consists of program control parameters, logic pattern assignments, and the interconnecting nets. PR2D reads the input data, searches the pin data file for data on each pattern type, generates a placement of the patterns, interconnects the patterns, and outputs the artwork for the layouts. By way of the program control parameters, individual functions of the PR2D program can be executed in separate steps. This capability increases the flexibility of the program and can reduce computer run time. By inspecting the output generated at each step of the process,

changes can be made to the data to improve the placement and routing on the final chip design. The PR2D program produces a map, or printer plot, that can be assembled into the final chip layout. All pertinent data regarding the layout of the chip is shown on the map. In addition, a printout of chip statistics is generated for designer review. Once the final chip design has been achieved, an artwork data file is generated for use in fabricating the chip mask. The PR2D program is written in FORTRAN IV for batch execution and has been implemented on a Xerox SIGMA V CP-V computer with 64K of 32 bit memory. The PR2D program was developed in 1978.

M80-10050 M&S Computing, Inc., Huntsville, Ala.
TPG: THE CADAT SYSTEM TEST PATTERN GENERATOR
FORTRAN IV 8,385 source statements
Xerox SIGMA V
MFS-25066 Price: Program $1000.00/Documentation $23.50

The CADAT system test pattern generator (TPG) was developed to aid in the checkout, fault detection, and fault isolation of complex digital circuits. The time and the effort involved in the manual generation of digital circuits. The time and the effort involved in the manual generation of digital test patterns can be a major limiting factor in the effective utilization of automatic testing. TPG can reduce the time and effort required for test program design from several months to several days. TPG performs all of the three major tasks associated with test program design. After examining the circuit, TPG develops a set of stimulus and response patterns for checkout, fault detection, and fault isolation. Next, TPG performs an extensive verification of the diagnostic potential of the developed test patterns. Finally, TPG creates a data file which can be interfaced with automated circuit testing equipment. Input to the TPG program consists of a nodal description of the digital circuit. A large digital component library is available for use in the circuit description. The user can easily introduce new components into the library collection at any time. Once the complete circuit has been input, TPG generates a NAND equivalent circuit as the basic model for test pattern generation. The use of NAND equivalents of components facilitates a realistic failure simulation which has proven more effective and efficient than individual component simulation. Signal propagation delay is simulated by using a fixed time delay across each NAND. This NAND time accounting has been found to have a higher resolution than using fixed component delay, since simultaneous nodes are being processed simultaneously throughout the entire circuit. By checking node status oscillations, TPG has a high probability of failure detection for race conditions which might otherwise go undetected. Once TPG has analyzed the model, generated a test pattern, and verified the validity of the test pattern, the stimulus data is prepared for use in testing the actual device. In order for the device to actually be tested or accurately simulated, the TPG generated stimulus data must be transformed into forms acceptable as input to logic test equipment or to a software logic simulator. The TPG package includes an interface program (TPGITF) to utilize the TPG stimulus data to generate TOIL test sequences for the MACRODATA-200 LSI tester and to generate excitation input for the CADAT system logic simulator program LOGSIM. The TPG program is written in FORTRAN IV for batch execution and has been implemented on a Xerox SIGMA V computer. The TPG program was originally developed in 1971 and was last updated in 1976.

M80-10051 Radio Corp. of America, New York.
FETSIM: THE CADAT SYSTEM FIELD EFFECT TRANSISTOR SIMULATOR
FORTRAN IV 1,638 source statements
Xerox SIGMA V
MFS-25067 Price: Program $600.00/Documentation $10.00

The CADAT system field effect transistor simulator (FETSIM) was developed to perform static d.c. and transient analyses of MOS (Metallic Oxide Semiconductor) type circuits. Circuits employing N-MOS and P-MOS transistors in either bulk or an SOS (Silicon on Saphire) technology and almost any combination of R-C elements may be analyzed with FETSIM. The program requires as input data a complete circuit topology description, device parameters, process parameters, and control parameters. The use may also specify initial node conditions and the input pulse format. For example, pulse rise time, fall time, width, and time between succeeding pulses are all independently controlled. FETSIM offers the circuit designer a versatile tool for analyzing MOS type circuits. FETSIM is based on a sophisticated mathematical model that can accurately handle N-MOS, P-MOS, bulk, and SOS devices. By considering doping levels of the ionized acceptors (or donors) in the substrate level, several second-order physical effects are implicitly accounted for. They include the apparent decreased carrier mobility resulting from heavy substrate doping and the gating effect associated with stacked devices. Sensitivity to process changes is maintained by requiring such data as threshold voltages and doping levels as input. Intrinsic MOS phenomena such as parasitic feedback capacitance and variation of threshold voltage with source potential are handled implicitly by the model. FETSIM transforms the input data into a set of nodal equations. These ordinary differential equations are then numerically integrated by the program. FETSIM output consists of a listing of the node voltages and all transistor currents as a function of time. The FETSIM program is written in FORTRAN IV for batch execution and has been implemented on a Xerox SIGMA V with a central memory requirement of approximately 45K of 32 bit words. The FETSIM Program was developed in 1974 and was last updated in 1977.

M80-10052 M&S Computing, Inc., Huntsville, Ala.
PWB: THE CADAT SYSTEM PRINTED WIRING BOARD SYSTEM
FORTRAN IV 17,914 source statements
Xerox SIGMA V
MFS-25464 Price: Program $1900.00/Documentation $22.00

The CADAT system printed wiring board system (PWB) was developed to provide circuit designers with automated techniques for the design of printed circuit boards and hybrid circuit boards. The PWB system is comprised of four design automation programs: the preprocessor, the placement program, the organizer program, and the router program. The preprocessor program combines user supplied data and predefined library data to produce detailed input for the placement program. The user supplied data consists of a list of components to be placed on the board, a list of the desired connections between components, and board identification information. The library data consists of physical size and pin placement data for each component as well as a description of the board area and pin logic information. From this data the preprocessor prepares the Placement Input File (PIF). The placement program utilizes the PIF data to automatically assign components to specific areas of the board. This program attempts to optimize the placement solution in terms of the interconnection characteristics between components. A Pin Connection File (PCF) is generated and passed to the organizer program. The organizer program converts the PCF data into a list of pin pairs and determines the board layer on which the pin pair should be placed. The program also determines the optimal order in which the router program should attempt to layout the paths connecting the pin pairs. The router program attempts to determine the wire paths which are to be used to connect each pin pair on the circuit board. The router program obtains information on the pin pairs to be connected and the available wire path area on each board layer from files generated by the organizer program. Once router has determined a viable layout, a printed image of the wire paths on each board layer and an artwork file are generated. An optional artwork tape for hybrid dielectric isolation boards may be generated. These programs are written on FORTRAN IV for batch execution and have been implemented on a Xerox SIGMA V computer. The PWB system was developed in 1973.

M80-10053 M&S Computing, Inc., Huntsville, Ala.
NTRAN: THE CADAT SYSTEM NETWORK TRANSLATOR PROGRAM
FORTRAN IV 5,361 source statements
Xerox SIGMA V
MFS-25055 Price: Program $650.00/Documentation $12.00

The CADAT system network translator program (NTRAN)

was developed to convert cell net data, as used by automatic layout programs, into logic gate models for use by logic test and simulation programs. The NTRAN input consists of either a place route and fold (PRF) or a place and route in two dimensions (PR2D) layout data deck. Output consists of either a test pattern generator (TPG) or logic simulation (LOGSIM) logic circuitry data deck. Use of the NTRAN program can reduce the workload of the integrated circuit designer. Instead of having to build both the cell net data circuit description and the logic gate model circuit description, the designer need only build the former. Since both sets of data describe the same circuit, the NTRAN program acts as a translator. Thus, once the layout cell net data has been developed, it may be translated and used as input for logic simulation and test pattern generation programs. The NTRAN program is written in FORTRAN IV for batch execution and has been implemented on a Xerox SIGMA V computer. The NTRAN program was developed in 1975.

M80-10054 Radio Corp. of America, Camden, N. J.
THE CADAT SYSTEM MULTIPORT IN TWO DIMENSIONS PROGRAM
FORTRAN IV 32,312 source statements
Xerox SIGMA V
MFS-25065 Price: Program $1750.00/Documentation $9.00

The CADAT system multiport in two dimensions program (MP2D) was developed as a placement and routing aid for processing double-ended cell equivalents of the high speed, silicon-on-sapphire (SOS) standard cell family. MP2D incorporates two major innovations in large scale integrated (LSI) array design. One of these innovations enables the program (1) to automatically route interconnections to either the top or bottom of each cell in such a way as to minimize total wire length, as well as total wiring or interconnection surface; and (2) to make connections between cells on nonadjacent rows by routing the interconnections directly across or through other intermediate cell rows. The other innovation relates to the unique feature of the circuit cell that permits the input-output connections of the circuit to be accessed at either the top or the bottom of the cells. Use of this multiport placement and routing program can result in substantial savings of chip area because of the reduced area requirements for wiring which previously was the largest user of chip area. The MP2D program provides substantial improvements over the single entry programs available for placement and routing. The basic purpose of the MP2D program is to design high density LSI arrays. Input to MP2D consists of control parameters, logic pattern assignments, and node connectivity data. MP2D determines a two dimensional placement of the cells on the placement surface and a two dimensional routing of connections among the cells. The generated output includes artwork instructions which can be employed in generating the artwork commands for plotting the final mask. The use of double-entry and 'feedthrough' cells permits MP2D to greatly reduce the area and wiring requirements on the chip. The MP2D program is written in FORTRAN IV for batch execution and has been implemented on a Xerox SIGMA V computer with the CP-5 operating system and has a central memory requirement of approximately 56K of 32 bit words. The MP2D program was developed in 1977.

38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

M80-10055 Naval Ship Engineering Center, Washington, D. C.
RAP: RELIABILITY AND AVAILABILITY PROGRAM
PL/1 (95 percent), Assembler (5 percent) 3,271 source statements
IBM 360
DOD-00068 Price: Program $650.00/Documentation $17.00

The special characteristics of systems designed for naval shipboard use require a special type of analysis for determining systems reliability, maintainability, and availability. The Reliability and Availability Program (RAP) was developed to fill this requirement. There are several unique features which differentiate shipboard systems from aircraft or spacecraft systems. The long duration of naval missions and the maintenance skill available allow for design tradeoffs between onboard repair capability and equipment redundancy. The broad range of failure and repair characteristics require the selection of different maintenance and logistic support policies for the total of the systems installed. The long logistic delay time involved in obtaining repair items not carried in the onboard inventory of spares make the design of back-up, degraded capability, modes of operation a necessity. The RAP program provides the reliability analyst with a realistic means of predicting the availability of shipboard systems and the effects of altering the system environment, including changes in repair and operating strategies. The RAP program models the probabilistic behavior of a set of equipment as a continuous time, homogeneous, discrete state Markov process. The model used in the RAP program is devided into a spatial model which organizes space into a meaningful arrangement of hardware characteristics and a temporal model which organizes time into phases which control the exact characteristics of the system at any given time. The system is considered to be composed of blocks and repair facilities. A block is an entity which actually performs a part of the function required by the system and is usually associated with a unit of hardware. Each block may have a redundancy factor with both active and standby components. Repair facilities represent the spares and skills available in the event of hardware failure. The temporal model is composed of two time-lines. The ship time-line divides time into ship mission phases. The system time-line divides time into system operational phases. The user supplies RAP with a description of the blocks, the repair facilities, the system states, the initial condition, the mission phases, the calculations to be made, and the changes that occur in the system from phase to phase. RAP computes the statistical probability of the system being in a given macrostate during the mission. RAP further translates these statistics into a measure of system reliability and availability for each phase of the mission. This program is written in FORTRAN IV for batch execution and has been implemented on an IBM 360 computer with a central memory requirement of approximately 104K of 8 bit bytes. The RAP program was developed in 1976.

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance*.

M80-10056 Boeing Aerospace Co., Seattle, Wash.
BOPACE3D: BOEING PLASTIC ANALYSIS CAPABILITY FOR ENGINES, VERSION 6
FORTRAN IV 14,131 source statements
UNIVAC 1100
MFS-23814 Price: Program $1750.00/Documentation $33.50

The Boeing Plastic Analysis Capability for Engines (BOPACE3D) is a nonlinear stress analysis program based on a very general family of isoparametric finite elements. Although the development of BOPACE3D has been heavily influenced by the requirements for engine analysis, in particular the space shuttle main engine, it is a general program applicable to many types of nonlinear structures. BOPACE3D is capable of performing a stress analysis on a structure subjected to very high temperatures, large plastic creep effects, and geometric nonlinearities, while experiencing cyclic thermal and mechanical loads. BOPACE3D includes several advanced analysis features such as substructuring, an out-of-core Gauss wavefront equation solver, multipoint constraints, combined material and geometric nonlinearities, automatic calculation of inertia effects, follower forces, singular

crack-tip elements, and axisymmetric capabilities. The basic purpose of classical constitutive theory in an elasto-viscoplastic program such as BOPACE3D is to provide incremental relations between stresses and strains. BOPACE3D uses these relations in conjunction with the standard finite element stiffness method to obtain an efficient solution approach for an important class of nonlinear structural analysis programs. Elastic, plastic, thermal, and creep deformations, and the nonlinear dependence of all deformations on temperatures are accurately accounted for in the BOPACE3D solution. The material theory used in BOPACE3D includes a combined isotropic/kinematic plastic hardening theory and a generalized approach to cyclic load reversal. A family of isoparametric finite elements are provided for structure modeling. The simplest elements of this family are the 2-node rod, the 4-node quadrilateral, and the 8-node brick. Various higher order elements are available with each basic element edge containing up to five arbitrarily spaced nodes. The ability to arbitrarily space edge nodes and to have different numbers of edge nodes on different edges of the same element provides versatility in representing complex geometries. To relieve the user of much of the effort required in developing a complex finite element model, an automated data generation capability is provided. The BOPACE3D program is written in FORTRAN IV for batch execution and has been implemented on a UNIVAC 1100 series computer with a segmented central memory requirement of approximately 56K of 36 bit words. Version 6 of the BOPACE3D program was released in 1978.

M80-10057* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AN ALL FORTRAN VERSION OF NASTRAN FOR THE VAX
FORTRAN 320,000 source statements
DEC VAX
GSC-12600 Price: Documentation; Theoretical Manual $25.00, User's Manual $50.00, Programmer's Manual $85.00, Demonstration Manual $15.00/Lease $4,000.00

The NASA Structural Analysis program (NASTRAN) was developed in the mid-1960's by the National Aeronautics and Space Administration to provide its research centers with a single, general purpose finite element computer program for structural analysis. Besides being efficient, versatile, and convenient to use, NASTRAN can be easily modified and expanded to accommodate new problem areas and new computer configurations without major redevelopment. Applications of NASTRAN extend to almost every type of structure and construction. Structural elements provide for the specific representation of the more common types of construction including rods, beams, shear panels, plates, and shells of revolution. More general structures can be analyzed by using combinations of these elements and by the use of general elements. Control systems, aerodynamic transfer functions, and other nonstructural features can be incorporated by the engineer into the structural analysis problem. The range of analysis that can be performed using NASTRAN includes: static response to concentrated or distributed loads, thermal expansion, and enforced deformation; dynamic response to transient loads, steady-state sinusoidal loads and random excitation; determination of real and complex eigenvalues for use in vibration analysis; dynamic stability analysis, and elastic stability analysis. The program also includes a limited capability for the solution of nonlinear problems, including piecewise linear analysis of nonlinear static response and transient analysis of nonlinear dynamic response. NASTRAN has been specifically designed to treat large problems with many degrees of freedom. The only limitations on problem size are those imposed by the practical considerations of computer run time and by the ultimate capacity of auxiliary storage devices. To reduce the central memory requirements, the NASTRAN program is overlayed into a series of sixteen links. One of these links is a control program which pulls the other links into core only as they are needed. This overlayed structure allows NASTRAN to offer the user a large selection of capabilities while requiring only a moderate amount of core resources. Computational procedures within NASTRAN provide for maximum obtainable efficiency in large problem solutions. This all FORTRAN version of NASTRAN was developed for implementation on the DEC VAX series computer under the VAX/VMS operating system. A recommended minimum configuration includes half a megabyte of central memory and 50 megabytes of disk space. A recommended best configuration includes 4 megabytes of central memory, two 176 megabyte disks, and the optional floating point accelerator. Level 17.5 of the NASTRAN Structural Analysis Computer Program is available by lease only for installation at domestic U.S. sites. The lease fee is $4,000.00 for the first year's use with an annual renewal fee of $3,000.00. If the program is to be installed at more than one geographic use location, additional programs are provided at $3,200.00 each for the first year with renewal fees of $2,400.00 annually. Level 17.5 documentation is available separately in any quantity according to the price schedule given. Lessees receive a source code copy, an object code copy, and an executable code copy of the program as well as a complete set of documentation.

M80-10058 Pennsylvania State Univ., University Park.
DESAP1: A STRUCTURAL DESIGN PROGRAM WITH STRESS AND DISPLACEMENT CONSTRAINTS
FORTRAN IV 5,152 source statements
IBM 360
MFS-25235 Price: Program $850.00/Documentation $28.50

Every structural design task is either directly or indirectly governed by certain optimality criteria. The designer is seldom required to create a structure that will only serve its primary function. Usually the designer is expected to meet additional design objectives such as minimum weight and cost. The DESAP1 program was developed to synthesize linear-elastic structures under static loads. The design objective with DESAP1 is to find the element sizes that minimize the total structural weight without changing the layout of the structure. The primary constraints used in the synthesis algorithm are upper limits on stresses and displacements. These stress limits may be prescribed in the form of yield criteria and local instability criteria. DESAP1 also allows for the use of secondary constraints consisting of minimum allowable element sizes and size proportion constraints. An iterative process is used in the synthesis, with each iterative step consisting of three parts. First, an analysis is performed on the current structure. Next, the results of that analysis are evaluated in terms of structure optimization. Finally, the results of the evaluation are utilized to redesign the structure. The classical stress ratio method is employed in the redesign with respect to stress constraints. This procedure will drive the final design to the fully stressed design, which may not coincide with the minimum weight distribution of material. For the displacement constraints, the redesign formula is obtained from the minimum weight criterion with element sizes being driven towards an optimal weight design. In the presence of both stress and displacement constraints, each iterative redesign operation first determines the element sizes from the stress ratio method. These results are then used as minimum size constraints during the application of the displacement-constrained redesign formulas. The result of the synthesis is a minimum weight structure adhering to the prescribed constraints. Input to DESAP1 consists of an initial finite element model of the structure and a set of constraint conditions. Basic structural elements available in DESAP1 include three dimensional bars, three dimensional beams, quadrilateral shear panels, anisotropic plane stress quadrilaterals and triangles, and anisotropic quadrilateral and triangular plates. A set of boundary elements is included to represent elastic supports and to apply constraints. The design procedure assumes that the loading is independent of element sizes. Allowances have been made for such size-dependent loads as thermal stresses and gravity loading. Output from DESAP1 consists of a redesign history, the final structural weight, and the redesigned element sizes. The DESAP1 program is written in FORTRAN IV for batch execution and has been implemented on an IBM 360 computer with a central memory requirement of approximately 300 K of 8 bytes. The DESAP1 program was developed in 1977.

M80-10059* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
NATP: THE NUMERICAL ANALYSIS OF TEMPERATURE PROFILES
FORTRAN IV 691 source statements
CDC 6000

LAR-12649 Price: Program $140.00/Documentation $10.00

Composite materials are ideally suited for lightweight structures because of their high strength-to-weight and stiffness-to-weight ratios. Before these materials can be incorporated into critical aircraft structures, their long term reliability must be assured. One structural aspect of these materials which must be well understood is the fatigue process. The Numerical Analysis of Temperature Profiles program (NATP) was developed as an aid in a new method in studying the fatigue damage process. Since detection of fatigue damage in composites is difficult or impossible using traditional nondestructive techniques, a new technique involving the thermographic examination of composite specimens under dynamic loading has been developed. The surface temperature profile generated by the cyclic loading of fatigue damaged material is the net result of a complex heat transfer process. NATP is a two dimensional, finite element heat transfer analysis program which takes into account orthotropic conduction, convection, and radiation. Thermographic data is analyzed by NATP to determine points of heat generation on the surface and thus the fatigue damage zone. NATP can also calculate temperature distribution for cases in which internal heat generation intensities or point applied heat fluxes are specified. The calculation of the location of the heat generation zones is performed by solving a heat balance equation at the restrained nodes. The finite element heat transfer analysis allows the effect of heat generation to be segregated from the effects of conduction, convection, and radiation. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6000 series computer with a central memory requirement of approximately 35K (octal) of 60 bit words. NATP was developed in 1979.

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells and batteries; global sources of energy; fossil fuels; geophysical conversion; hydroelectric power; and wind power.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *85 Urban Technology and Transportation.*

M80-10060 Rockwell International Corp., Pittsburgh, Pa.
ORBITING SOLAR ARRAY SIMULATION MODEL
FORTRAN IV 717 source statements
CDC CYBER 70
MSC-18558 Price: Program $140.00/Documentation $5.50

Solar arrays are becoming an increasing important means of generating power for earth orbiting spacecraft. Currently, almost all unmanned Earth satellites utilize solar array electrical power generation systems. Applications for solar arrays in the near future include providing power for space shuttle payloads and manned space stations. This computer program was developed to simulate the capabilities of Earth orbiting arrays. The model used is based on an improved version of a finite element radiation shape factor subprogram. The inherent simplicity and speed of the original subprogram has been augmented with an improved shadow evaluation technique to provide the user with an efficient array model. The program allows the characteristics of orbiting arrays to be evaluated with a minimum of user effort and computer cost. Input to the program consists of a brief description of the array and the orbital parameters. The orbital parameters are used to determine the direct solar radiation incident on the cells, incident solar radiation reflected to cells from the Earth, and the shadowing of any cells. Once the amount of thermal radiation gained and lost by the array is known, the amount of power which can be generated and the temperature of the array is determined. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC CYBER 170 series computer with a central memory requirement of approximately 76K (octal) of 60 bit words. This program was developed in 1979.

M80-10061* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HEAP: HEAT ENERGY ANALYSIS PROGRAM
FORTRAN IV 1,136 source statements
UNIVAC 1100
NPO-14835 Price: Program $460.00/Documentation $16.00

The need for an accurate method for predicting the thermal behavior of solar receivers, a method which can be used as a performance comparison tool, has become increasingly important with the rapid development of solar technology. A sufficiently general analytical model is needed which is both an adequate idealization of the physical system and capable of being expressed by a relatively simple mathematical description. The heat energy analysis program (HEAP) was developed to fill these needs. HEAP has the basic capability to solve any general heat transfer problem but also has some specific features that are custom-made for analyzing solar receivers. HEAP can be utilized in the detailed analysis of solar receivers not only to predict their performance under varying solar flux, ambient temperature, and local heat transfer rates but also to detect the locations of hot spots and metallurgical difficulties, and to predict performance sensitivity of neighboring component parameters. The basic methodology utilized by HEAP is based on a nodal, finite difference approach to the heat transfer calculations. The receiver is discretized in space by nodes or zones and in time by time increments. Between any two arbitrary nodes, the differential heat transfer rate equations are expressed with all modes of heat transfer included. The net energy stored in each node is calculated using the first law of thermodynamics including the energy exchange to and from neighboring nodes. For steady-state solutions, a Newton-Raphson iteration solution is used to solve for the temperature distribution of the equilibrium nodes and the net energy stored at the source/sink nodes. For transient solutions, a forward marching finite difference numerical technique is used to solve for the nodal temperature histories. Input to the HEAP program consists of solar flux distributions, optical and physical properties, fluid flow rates, and boundary conditions. The radiation view factors are supplied by the user in terms of a subroutine. Output generated by HEAP includes temperature distribution, fluid outlet conditions, accumulated energy extracted, receiver efficiency, and heat losses. The HEAP program is written in FORTRAN 4 for batch execution and has been implemented on a UNIVAC 1100 series computer with a central memory requirement of approximately 47K of 36 bit words. HEAP was developed in 1979.

61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, and algorithms.

M80-10062 Higher Order Software, Inc., Cambridge, Mass.
FLOWCHARTER: A UNIVERSAL STRUCTURED DESIGN DIAGRAMMER
PASCAL 11,159 source statements
CDC 6000
LAR-12548 Price: Program $1000.00/Documentation $21.50

The Universal Structured Design Diagrammer (FLOWCHARTER) was developed as a tool for documenting and understanding computer programs. The FLOWCHARTER is termed universal because it can produce flowcharts and concordances for any program written in virtually any language. The FLOWCHARTER is termed a structured design diagrammer because the generated flowcharts are presented in a concise tree-like format appropriate for representing the flow of control in a structured program. The FLOWCHARTER can be used to provide standardized documentation for any type of finished program. It can also be used in the development and debugging phase to clearly exhibit the structure of a program. In order to flow chart a program in a given language, the user must provide FLOWCHARTER with

a description of the programming language grammar. Three sets of rules are needed to describe the grammar. The first set must be a list of syntax rules in Backus-Naur Form (BNF). These re-write rules allow FLOWCHARTER to do a bottom-up parse of the input program. The next set required is a list of sematic rules, in one-to-one correspondence with the syntactic rules, which specify how a particular construct is to be diagrammed. Last is a set of concordance rules, again in one-to-one correspondence with the syntactic rules, which are used to isolate positions where identifiers may appear and to classify these identifiers as variables or as procedure names. The preparation of this list is a nontrivial task; however, the list is only prepared once for each language. A grammar description for PASCAL is included with the FLOWCHARTER distribution package. Once the grammar description has been developed, the user need supply only the source code to be diagrammed. The FLOWCHARTER automatically produces a flow diagram and a concordance. The diagram produced is quite different from traditional types of flow charts. The structured design diagram represents the main flow of the program in the top-down format, with increasing levels of detail explicitly indicated. This structured design diagram approach is particularly appropriate for languages with higher level constructs such as case, iterative loops, or logical dependent execution blocks. The source code for the FLOWCHARTER system is written for the PASCAL Release 2 compiler, as distributed by the University of Minnesota. FLOWCHARTER is intended for batch execution and has been implemented on a CDC 6000 series computer with a central memory requirement of approximately 43K (octal) of 60 bit words. The FLOWCHARTER was developed in 1979.

62 COMPUTER SYSTEMS

Includes computer networks.

M80-10063* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MPSS: MULTI-PURPOSE SYSTEM SIMULATOR
FORTRAN IV (99 percent), Assembler (1 percent) 13,176 source statements Updated; previously announced as M78-10005 Prepared in cooperation with Computer Sciences Corp., Greenbelt, Md.
IBM 360
GSC-12333 Price: Documentation $45.50/Lease $950.00

The intelligent selection of one computer system from among several candidate systems requires an estimate of system performance and behavior under various operating loads. The complexity of the system and subsystems involved precludes the adoption of a purely analytical approach to selection. Therefore, a flexible system modeling capability is required to evaluate the relative performance of competitive computer systems. The Multi-Purpose System Simulator (MPSS) was developed to provide such a model for simulating computer systems. MPSS can be employed in evaluating competitive systems as well as isolating areas for enhancement of existing or proposed systems. MPSS can even model complicated multi central processor systems involving data exchange among computers. MPSS performs an event-driven simulation of a computer system by employing a model propagated on a time step basis. The system to be simulated is broken down into the categories of hardware, software, and workload. Hardware consists of central processing units (CPUs), extended memory units (EXMs), peripheral devices (PERs), communication lines, and communication bases. Software consists of application modules and operating system functions. Workload consists of various types of jobs, each arriving at certain rates and invoking a fixed sequence of application modules. Data blocks arriving from outside the system are scheduled in bursts for entry into the simulated system. Once the user has specified the hardware, software, and workload, the simulation is performed. Statistics output by MPSS include utilization of hardware components, number of calls made to each software module, and the number of data blocks throughput. MPSS also maintains a count of the number of data blocks, software module calls, and PER access attempts ignored due to insufficient resources. The performance parameters measured by the model include CPU processing times and idle times, data block backlogs, data block response times, individual software module response times, communication line usage, and statistics on PER utilization and contention. The MPSS system is written in FORTRAN IV for the IBM FORTRAN H compiler and IBM OS ASSEMBLER for batch execution and has been implemented on an IBM 360 series computer with a central memory requirement of approximately 550K of 8 bit bytes. The MPSS distribution package includes a preprocessor program developed to simplify and expedite the creation of input data for the MPSS program. The MPSS program was developed in 1976 and last updated in 1980. The MPSS system program product is available by lease for a period of 10 years for a fee of $950.00 to domestic U.S. lessees. The leased program product includes the program source code and one complete set of documentation. Additional copies of the documentation may be purchased at any time.

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

M80-10064* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
EXTREME MEAN AND ITS APPLICATIONS
FORTRAN IV 391 source statements Prepared in cooperation with Systems Development Corp., Eatontown, N.J.
CDC 6000
FRC-11056 Price: Program $140.00/Documentation $7.00

In many applications where observations are assumed to follow a normal distribution, interest often centers around the extreme value observed. In some sense, the extreme value usually indicates a tolerance for a system. The actual maximum and minimum sample values in such applications are usually of limited usefulness, because maximum and minimum tend to change with the sample size. This computer program was developed to calculate the density and distribution functions and the confidence intervals of the extreme mean for a given set of data. The extreme mean in this program is defined as the mean of the truncated normal distribution above or below a preassigned p-th percentile. As the sample size increases, the variance of the unbiased estimate of the extreme mean converges to the Cramer-Rao lower bound. This program is written in FORTRAN IV for batch execution and has been implemented on a CDC 6000 series computer with a central memory requirement of approximately 44K (octal) of 60 bit words. This program was developed in 1979.

71 ACOUSTICS

Includes sound generation, transmission and attenuation.

For noise pollution see *45 Environment Pollution*.

M80-10065* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A COMPUTER CONTROLLED INSTRUMENTATION SYSTEM FOR THIRD-OCTAVE ANALYSIS
FORTRAN IV (50 percent), Assembler (50 percent) 1,855 source statements
HP 2100
LAR-12436 Price: Program $200.00/Documentation $13.00

This computer program was developed to aid in the calculation of an effective perceived noise level (EPNL) from one-third octave band spectrum data. The program uses the measured physical properties of a recorded aircraft flyover to determine the noise evaluation quantity designated as EPNL. The calculation is performed in accordance to FAA regulations. The EPNL is calculated from a time sequence of tone adjusted perceived

noise levels which are calculated from recorded one-third octave band spectra data. The tone adjustments are determined by a procedure which estimates the extent of spectral irregularities at any given instant of time. The resultant EPNL value represents a single number measure of the complex noise as related to subjective response. This is a flexible program which provides for various data analysis techniques to be employed in examining one set of data. The user can select among several noise correction options, test statistics, and number of spectra to be included. The user may also request that a data averaging technique be used employing either linear or exponential averaging. Output from the program includes the spectral data printed in tabular form, a time history plot of the tone corrected perceived noise level, plots of selected one-third octave data, and the EPNL. This program is written in FORTRAN IV and ASSEMBLER for implementation on the HP 2100 mini-computer. It is intended that this program be used as part of an instrumentation system consisting of the HP 2100, an analog tape recorder, a multifilter/multiplexed detector instrument, a time code reader, and a tape search unit. This program was developed in 1978.

77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

M80-10066* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

WETAIR: THERMODYNAMIC AND TRANSPORT PROPERTIES OF AIR-WATER MIXTURES

FORTRAN IV 2,635 source statements

IBM 360

LEW-13432 Price: Program $440.00/Documentation $4.00

In research on gas turbine engines, measured temperatures and pressures of the working fluid are compared with ideal temperatures and pressures that would be obtained if there were no losses in the system. In this manner, the performance of system components can be quantitatively evaluated. This evaluation method requires a procedure that can accurately calculate ideal temperatures and pressures while accounting for real gas effects. The WETAIR computer routine was developed to calculate the thermodynamic and transport properties of air water mixtures. It determines the thermodynamic state of an air water mixture from assigned values of temperature and density, pressure and density, temperature and pressure, pressure and entropy, or pressure and enthalpy. WETAIR interpolates thermodynamic and transport properties of dry air and water (steam) from tabular data. It then uses simple mixing laws to obtain the properties of air water mixtures. Properties of mixtures with water contents below 40 percent (by mass) can be calculated at temperatures from 273K to 1,497K and pressures to 450 MN/square meter. Dry air properties can be calculated at temperatures as low as 150K. Water properties can be calculated at temperatures to 1,747K and pressures to 100 MN/square meter. The WETAIR routine is written in FORTRAN IV for batch execution and has been implemented on an IBM 360 series computer with a central memory requirement of approximately 77K of 8 bit bytes. WETAIR was developed in 1979.

85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

M80-10067* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

ELECTRIC VEHICLE MODELS (HP 67/97 AND TI-59 VERSIONS)

Key stroke instructions

HP 67/97 or TI-59 calculators

NPO-15236 Price: Program/Documentation $75.00

This package consists of seventeen programmable calculator programs developed to predict the operational performance of electric vehicles. These programs, and the supporting documentation, should provide the user with valuable insight into the performance of electric vehicles and electric vehicle batteries. These programs are not intended as substitutes for the more complex and detailed computer programs, but should prove valuable in performing rough calculations and obtaining a feeling for electric vehicle operational parameters. The available programs include: road load to power and power density conversions, several battery simulation models, wind weighting factor and tire rolling resistance calculations, constant speed and wide open throttle simulators, and percent gradeability at speed calculations. The documentation gives a full description of the calculation or simulation performed by each program, along with a set of key stroke instructions. Instructions are included for both the HP-67/97 and the TI-59. This collection of programs was developed in 1980.

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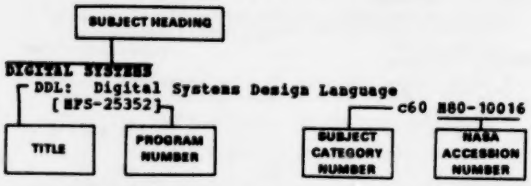

The subject heading is a key to the subject content of the document. The titles, with title extensions if present, are arranged under each subject heading in ascending accession number order. The program number is the number assigned in the COSMIC inventory to identify the coded source. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category.

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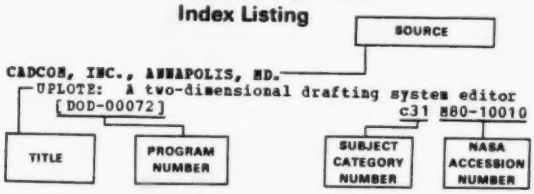
Typical Originating Source Index Listing



Listings in this index are arranged alphabetically by originating source. The title of the document provides the user with a brief description of the subject matter. The program number is the number assigned in the COSMIC inventory to identify the coded source. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category. The titles are arranged under each corporate source in ascending accession number order.

A

ABACUS PROGRAMMING CORP., SANTA MONICA, CALIF.
CRTSIM: Shuttle CRT display simulator
[MSC-18872] c16 M80-10042

B

BATTELLE MEMORIAL INST., COLUMBUS, OHIO.
AIRCL: A programmed system for generating numerical control tapes for airplane models
[LAR-12494] c02 M80-10035

BOEING AEROSPACE CO., SEATTLE, WASH.
BOPACE3D: Boeing plastic analysis capability for engines, version 6
[MFS-23814] c39 M80-10056

C

COMPUTER SCIENCES CORP., GREENBELT, MD.
MPSS: Multi-Purpose System Simulator
[GSC-12333] c62 M80-10063

G

GRUMMAN AEROSPACE CORP., BETHPAGE, N.Y.
WIBCO: Wing body code for transonic flow field analysis of wing-fuselage configurations
[LAR-12702] c02 M80-10036

H

HIGHER ORDER SOFTWARE, INC., CAMBRIDGE, MASS.
FLOWCHARTER: A universal structured design diagrammer
[LAR-12548] c61 M80-10062

J

JET PROPULSION LAB., CALIFORNIA INST. OF TECH., PASADENA.
HEAP: Heat Energy Analysis Program
[NPO-14835] c44 M80-10061
Electric vehicle models (HP 67/97 and TI-59 versions)
[NPO-15236] c85 M80-10067

M

M&S COMPUTING, INC., HUNTSVILLE, ALA.
MAPS2: CADAT system Mask Analysis Program
[MFS-25054] c33 M80-10046
LOGSIM: CADAT system logic simulation program
[MFS-25183] c33 M80-10047
TPG: The CADAT system Test Pattern Generator
[MFS-25066] c33 M80-10050
PWB: The CADAT system Printed Wiring Board system
[MFS-25464] c33 M80-10052
NTRAN: The CADAT system network translator program
[MFS-25055] c33 M80-10053

N

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.
Aeroelastic analysis for rotorcraft in flight or in wind tunnel
[ARC-11150] c02 M80-10034

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. HUGH L. DRYDEN FLIGHT RESEARCH CENTER, EDWARDS, CALIF.
Extreme mean and its applications
[FRC-11056] c65 M80-10064

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.
GSE: General Ground Support Equipment Software System
[GSC-12536] c09 M80-10040
SSPTA: Simplified Shuttle Payload Thermal Analyzer
[GSC-12638] c16 M80-10043
An all FORTRAN version of NASTRAN for the VAX
[GSC-12600] c39 M80-10057
MPSS: Multi-Purpose System Simulator
[GSC-12333] c62 M80-10063

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LANGLEY RESEARCH CENTER, HAMPTON, VA.
AIRCL: A programmed system for generating numerical control tapes for airplane models
[LAR-12494] c02 M80-10035
TWINTAN: A transonic wall interference analysis method
[LAR-12753] c09 M80-10039
Interpretive computer simulator for the NASA Standard Spacecraft Computer-II
[LAR-12603] c19 M80-10045
NATP: The Numerical Analysis of Temperature Profiles
[LAR-12649] c39 M80-10059
A computer controlled instrumentation system for third-octave analysis
[LAR-12436] c71 M80-10065

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. LEWIS RESEARCH CENTER, CLEVELAND, OHIO.
Two-dimensional potential flow through deflected nozzles
[LEW-13461] c07 M80-10038
WETAIR: Thermodynamic and transport properties of air-water mixtures
[LEW-13432] c77 M80-10066

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.
ARTWORK: The CADAT system integrated circuit artwork program
[MFS-25017] c33 M80-10048

NAVAL SHIP ENGINEERING CENTER, WASHINGTON, D. C.
NAP: Reliability and Availability Program
[DOD-00068] c38 M80-10055

P

PENNSYLVANIA STATE UNIV., UNIVERSITY PARK.
DESAP1: A structural design program with stress and displacement constraints
[MFS-25235] c39 M80-10058

SOURCE

R

RADIO CORP. OF AMERICA, CAMDEN, N. J.
The CADAT system multiport in two dimensions program
[NPS-25065] c33 N80-10054
RADIO CORP. OF AMERICA, NEW YORK.
PR2D: The CADAT system Place and Route in Two Dimensions program
[NPS-25058] c33 N80-10049
PETSIM: The CADAT system field effect transistor simulator
[NPS-25067] c33 N80-10051
ROCKWELL INTERNATIONAL CORP., DOWNEY, CALIF.
A time domain analysis of free responses
[NSC-18673] c16 N80-10044
ROCKWELL INTERNATIONAL CORP., PITTSBURGH, PA.
Orbital deployment plotting programs
[NSC-18614] c16 N80-10041
CRTSIM: Shuttle CRT display simulator
[NSC-18872] c16 N80-10042
Orbiting solar array simulation model
[NSC-18558] c44 N80-10060

S

SKF INDUSTRIES, INC., KING OF PRUSSIA, PA.
CYBEAN: High speed cylindrical roller bearing analysis
[LEW-13393] c07 N80-10037
SYSTEMS DEVELOPMENT CORP., MATONTOWN, N. J.
Extreme mean and its applications
[PRC-11056] c65 N80-10064

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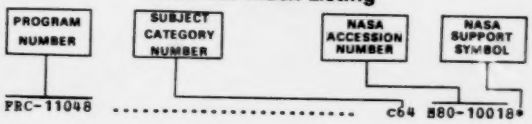
Typical Program/Accession Number Index Listing



Listings in this index are arranged alphanumerically by program number. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category. An asterisk (*) indicates NASA support.

ARC-11150 ..... c02 N80-10034*

DOD-00068 ..... c38 N80-10055

PRC-11056 ..... c65 N80-10064*

GSC-12333 ..... c62 N80-10063*
GSC-12536 ..... c09 N80-10040*
GSC-12600 ..... c39 N80-10057*
GSC-12638 ..... c16 N80-10043*

LAR-12436 ..... c71 N80-10065*
LAR-12494 ..... c02 N80-10035*
LAR-12548 ..... c61 N80-10062
LAR-12603 ..... c19 N80-10045*
LAR-12649 ..... c39 N80-10059*
LAR-12702 ..... c02 N80-10036
LAR-12753 ..... c09 N80-10039*

LEW-13393 ..... c07 N80-10037
LEW-13432 ..... c77 N80-10066*
LEW-13461 ..... c07 N80-10038*

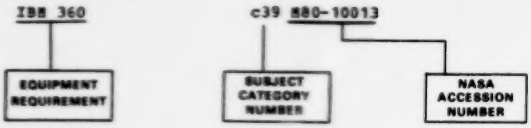
MFS-23814 ..... c39 N80-10056
MFS-25017 ..... c33 N80-10048*
MFS-25054 ..... c33 N80-10046
MFS-25055 ..... c33 N80-10053
MFS-25058 ..... c33 N80-10049
MFS-25065 ..... c33 N80-10054
MFS-25066 ..... c33 N80-10050
MFS-25067 ..... c33 N80-10051
MFS-25183 ..... c33 N80-10047
MFS-25235 ..... c39 N80-10058
MFS-25464 ..... c33 N80-10052

MSC-18558 ..... c44 N80-10060
MSC-18614 ..... c16 N80-10041
MSC-18673 ..... c16 N80-10044
MSC-18872 ..... c16 N80-10042

NPO-14835 ..... c44 N80-10061*
NPO-15236 ..... c85 N80-10067*

EQUIPMENT REQUIREMENTS INDEX

Typical Equipment Requirements Index Listing



Equipment requirements are arranged in alphanumeric sequence. The subject category number indicates the subject category in the abstract section in which the citation is located. The NASA accession number denotes the number by which the citation is identified within the subject category.

CDC CYBER 70
c44 NSC-10060

CDC CYBER 160
c16 NSC-10044

CDC CYBER 170
c02 NSC-10036
c09 NSC-10039

CDC CYBER 175
c19 NSC-10045

CDC 6000
c02 NSC-10035
c39 NSC-10059
c61 NSC-10062
c65 NSC-10064

DEC PDP-11
c09 NSC-10040

DEC VAX
c39 NSC-10057

HP 67/97 OR TI-59 CALCULATORS
c85 NSC-10067

HP 2100
c71 NSC-10065

HP9830A
c16 NSC-10041

IBM 360
c02 NSC-10034
c16 NSC-10043
c38 NSC-10055
c39 NSC-10058
c62 NSC-10063
c77 NSC-10066

IBM 370
c16 NSC-10042

UNIVAC 1100
c07 NSC-10037
c39 NSC-10056
c44 NSC-10061

XEROX SIGMA II
c33 NSC-10046

XEROX SIGMA V
c33 NSC-10047
c33 NSC-10048
c33 NSC-10049
c33 NSC-10050
c33 NSC-10051
c33 NSC-10052
c33 NSC-10053
c33 NSC-10054

EQUIPMENT

*U.S. GOVERNMENT PRINTING OFFICE : 1980 O-311-379/1450